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Bell Telephone MAGAZINE

"ALLO MAROC!"

SKILLED MANPOWER FOR THE SIGNAL CORPS

WAR EMERGENCY STOCKS IN THE BELL SYSTEM

GETTING ALONG WITH WHAT WE HAVE

SCIENCE IS INTERNATIONAL

American Telephone & Telegraph Company · New York

Bell Telephone Magazine

September 1943

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"The ideal and aim of the American Telephone and Telegraph Company and its Associated Companies is a telephone service for the nation, free, so far as humanly possible, from imperfections, errors, or delays, and enabling anyone anywhere to pick up a telephone and talk to anyone else anywhere else, clearly, quickly and at a reasonable cost."

A Medium of Suggestion & a Record of Progress

Published for the supervisory forces of the Bell System by the Information Department of American Telephone and Telegraph Company, *195 Broadway, New York, N. Y.*

Who's Who & What's What

in This Issue

THAT THE Western Electric Company is doing a magnificent job of war production is known in general to Bell System people. But "Allo Maroc!" is the first comprehensive account—although necessarily incomplete in many details—of how big and how varied that job is. All who read it will be proud that this integral part of the System, its source of manufacture and supply, can make so effective a contribution to victory. Its author, C. L. STONG, joined the Engineer of Manufacture Department of Western Electric in 1926—after having been, among other things, a "cub" newspaper reporter and an aviator—and subsequently was for a time a field representative of Electrical Research Products Inc. during the conversion of silent motion pictures to sound. A member of Western's Public Relations Department since 1938, he was appointed Information Manager in 1941. Sandwiched in between his other duties have been visits to more than a hundred Army and Navy establishments for first-hand study of how electronics is helping to speed communications in World War II.

TO MATCH and surpass the swift and effective communications of the Nazi blitzkrieg, to maintain contact with forces fighting in the island jungles of the southwest Pacific, to make possible the coördination of far-flung action on many parts of the globe, have been among the tasks of the Signal Corps, U. S. Army, requiring all the expert knowledge and skill it could command. Much of this knowledge and skill has been supplied by the nearly 5,000 Bell System men who have volunteered for specific positions in its organization through the "affiliated plan." The story of this

C. L. Stong

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John W. Campbell

Linus E. Kittredge

Bayard A. Freed

Karl K. Darrow

plan's development and of a few accomplishments by the men enrolled under it is told by DONALD S. BRIDGMAN, who since Pearl Harbor has been the contact point at A. T. & T. headquarters with the Signal Corps and with the System companies in connection with the plan's day to day operation. An Ensign in the Naval Reserve Flying Corps in World War I, he entered the Ohio Bell in 1920 and a year later joined A. T. & T.'s Personnel Relations Department. Since that time he has been concerned with technical and staff employment and related personnel matters.

IN MODERN WAR, problems of matériel are not confined to the fighting forces. Just as military preparedness requires that arms and ammunition be provided to resist a possible enemy attack on our shores, so does it require that telephone supplies be available against such a contingency in order to insure against serious interruption to the country's communication facilities. How the Bell System has met this potential need for central office equipment and outside plant materials is described by JOHN W. CAMPBELL and LINUS E. KITTREDGE, both of whom are members of the Assistant Chief Engineer's division of the A. T. & T. Company's Department of Operation and Engineering. After ten years with what is now the New Jersey Bell Telephone Company, Mr. Campbell transferred to A. T. & T. in 1916, where since 1939 he has been Outside Plant Engineer of the O. & E. Department. Mr. Kittredge joined A. T. & T.'s Department of Development and Research in 1920. When this was consolidated with the Bell Telephone Laboratories in 1934, he worked there on problems of dial

(*Continued on page 204*)

Saving Paper

THE lighter stock and narrower margins which are evident in this issue accomplish, without loss of readability, a saving of paper of more than 20 percent.

U. S. ARMY SIGNAL CORPS PHOTO

ACROSS ICELAND marches this telephone cable as men of the Army Signal Corps establish another line of military communication in the course of their operations on many fronts. See "Skilled Manpower for the Signal Corps," page 164

Of All the Electronic and Communication Equipment Made in This Country for War, More Than One Third Has Come Off the Western Electric Company's Assembly Lines

"Allo Maroc!"

C. L. Stong

On November 8, 1942, a strange voice cut in on the frequency of the radio station, Radio Morocco, at Rabat:

"Allo Maroc! Allo Maroc! This is the transmitter of the American Armed Forces."

In a matter of minutes Arabs, Berbers, Sengalese, and Frenchmen were excitedly exchanging scraps of a message directed to them from that transmitter by the President of the United States: *"Mes Amis . . .* we come among you to repulse the invaders . . . have faith in our words . . . help us where you can . . . Vive la France èternelle!"—and all of the inhabitants but a scattered few were heeding specific admonitions from General Dwight D. Eisenhower and General Henri Honoré Giraud to lay down their arms and coöperate.

That message was the prelude to the arrival on African beaches of scores of snub-nosed invasion barges from which swarmed khaki-clad British and American boys. How many of them are alive today because of that "mystery" transmitter, no one can say. But their numbers must run into thousands.

The action, swift, sure, perfectly coördinated, is now history. Most Frenchmen, of course, felt more like cheering than battling. From Algiers to Casablanca, local inhabitants of the key cities generally stood idly on the sidewalks, enraptured; even milkmen kept delivering supplies as if nothing were happening. Words, far more than bullets, won the cause. Within 16 hours, General Alfonse Pierre Juin surrendered Algiers. And in less than a week the blue Atlas mountains and the Pillars of Hercules looked down on cities, where Odysseus sailed in the fabled dawn of Greece, to see American doughboys from the plains of Iowa and the green hills of Vermont quietly patrolling the crooked streets—and trying hard to look unconcerned.

When the "voice of the Ameri-

Republication of this article or any part of it is prohibited by military censorship.

can Armed Forces" first called upon loyal Frenchmen for support, many thought the words actually came from the broadcasting station at Rabat and that French Morocco already was in American and British hands. Vichyites and Nazis, who knew better, searched madly for the mysterious station and, not finding it, forced Radio Morocco to resort to jamming. But even the jamming didn't quite work. The mystery station shifted its frequency just a little and, for four days on and off, news from the battle fronts, warnings to civilians to take cover, appeals to loyal Frenchmen, continued to come through.

Nazis and Vichy French leaders in North Africa would have given a great deal to know where the mystery transmitter was located—although it wouldn't have done them much good. Off shore, over the horizon, lay the sinister shape of a great American battleship. Aboard her, under the

U. S. NAVY PHOTO

PERFECT TEAMWORK, even more than individual skill and daring, is responsible for our fighters' superiority in the air, say American airmen. Efficient radio communication between planes and with their base enables each squadron to fight as a coordinated team

protection of her deadly batteries and enclosed by a screen of destroyers, was a Western Electric 5 kilowatt radio broadcasting transmitter.

The story of how this transmitter, designed to bring to New Jersey listeners the usual entertainment fare and the "commercials" of the ether, happened to be aboard a battleship in action off the coast of Africa is one of the intriguing stories of the war.

It began September 29, 1942. Into Western Electric's Radio Division came the first "triple A" priority and directive ever seen by the men who work there on Government contracts.

The Amphibian Command needed a 5 kilowatt transmitter—in a rush! Every hour—every tick of the clock—counted. Its purpose and ultimate destination were not disclosed. No importance could be attached to the fact that manufacture of such apparatus had been suspended for the

U. S. ARMY SIGNAL CORPS PHOTO

GUN POSITIONS on an American troop transport look like this when seen from above. Telephones bring to the gun crews the orders which set all guns to bear on the target of enemy plane or ship

duration—that even replacement parts were becoming increasingly scarce. Only two facts mattered: the Company *had* manufactured such equipment, it *must* find such equipment and make delivery to Norfolk, Virginia—and would do so, somehow.

Division records disclosed that a 5 kilowatt transmitter had been delivered to radio station WHOM in Jersey City—that its installation had not been completed. With a lot of coöperation from all concerned, the equipment was turned over to the Government and rushed to Norfolk, Va., under Army guard. Simultaneously, the Company's Kearny Works dispatched replacements for the few missing parts, and a full complement of spares, to meet the transmitter at the Naval base.

OF ALL the Bell System men who participated in the work, only two Bell Telephone Laboratories' engineers knew why the Amphibian Command so desperately needed a transmitter. They disappeared in the feverish activity of Norfolk and were not heard from again until late in October. Their job, installing the transmitter aboard the warship, took precedence over everything.

During the last hurried days, the side of the deckhouse on the battleship was ripped open so the transmitter could be installed within—the most confined space, incidentally, in which such equipment had ever been set up. A generator, the only one the Army could locate in the time allotted, was rushed from a South Carolina cotton mill, and practically rebuilt on the job.

Then came the final, crucial test. The battlewagon steamed out of the roadstead and opened up her guns to see if the delicate parts of the transmitter could withstand the shock. They could and did—even the concussion of a five-inch gun not twenty feet away. Another Western Electric product was ready for battle action.

Western's Grave Responsibility

THAT IS but one incident in the war story of the Western Electric Company. It is an important incident because it illustrates the premium this war places on the qualities of initiative, coöperation, and dispatch. The full story of how Western Electric converted from its 73-year-old rôle as maker of Bell telephones and source of supply for the Bell System to that of a war-time arsenal of communications equipment for the fighting forces of the United States and the United Nations is rich in such incident. For today, Western Electric products in great variety help to coördinate Allied battle action throughout the world.

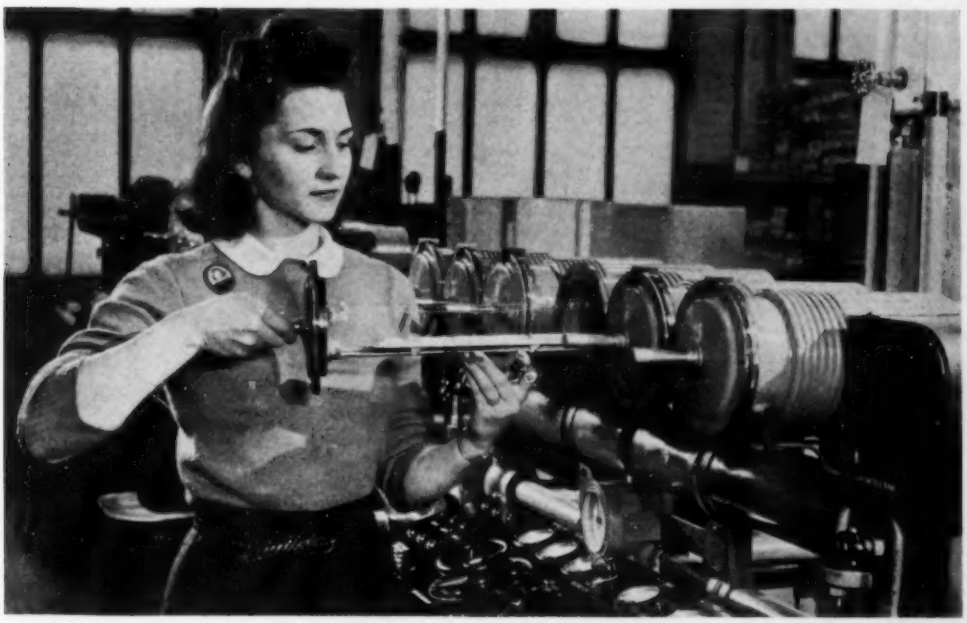
By any yardstick, its wartime job is the gravest responsibility of the Company's industrial career. In a recent telegram addressed to the employees, Major General H. C. Ingles, newly appointed Chief Signal Officer of the Army of the United States, said:

"Communications equipment you make is needed to bring victory on every fighting front. Radio made possible the landing on Attu when dense fog hid even the water from the decks of ships. In the Southwest Pacific, soldiers call the telephone a life or death necessity. In

the jungle, Army Air Forces warning-net teams, using radio, are making India virtually proof against surprise Jap attacks, and in Tunisia a portable radio station guided damaged American planes safely to the nearest airfield. Performance of all communication equipment in combat depends largely on the workmanship of the men and women who produce it. The army relies on you for the best."

To the full extent of its resources, the Company is trying to meet that responsibility.

Thus far, more than one third of all the electronic and communications equipment produced in the United States for war has come off its assembly lines.



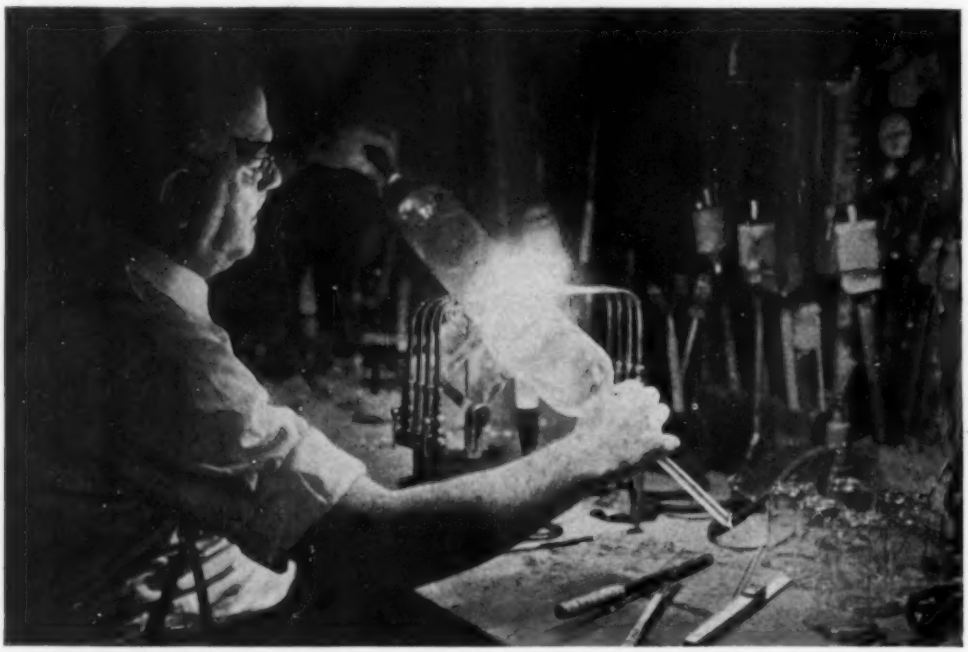
CRYSTALS used to stabilize frequencies in military radios are silver plated during the fine process of manufacture. Here a woman war worker in Western Electric's Hawthorne Works inserts a tray of crystal blanks in a silver-plating machine developed by Bell Laboratories engineers

Preparations in 1938

THIS WAR STORY may well begin with the blustery December day, back in 1938, when the manager of the Company's Specialty Products Division strode into a drab office of the old Munitions Building of the War Department in Washington and expectantly opened an empty, battered suitcase.

"Are they ready, Colonel?" he inquired.

Less than twenty-four hours earlier, the Colonel had asked Western Electric to undertake the manufacture of Command Sets in great number. This instrument is a specialized radio telephone which enables pilots while in flight to communicate with each other and with stations on the ground.



UNDER THE DEFT TOUCH of a craftsman in the Kearny Works of Western Electric, molten glass becomes an element of a water-cooled tube which may see service in a military radio communication unit

It was a tough assignment. Not just because of the problems of volume production or the pinch of a tight delivery schedule, but because of these plus specifications calling for almost impossibly close tolerances in manufacture.

To supply the listener needs of its peacetime broadcasting, America employs about 800 transmitters. To accommodate them, the available space on the air is divided into a number of broadcasting channels, and these are shared by the 800 stations. As long as each fellow sticks in his own groove, the system works pretty well and there is little "jamming." Even so, as every listener knows, the dials are fairly crowded and sets must be tuned carefully for good reception.

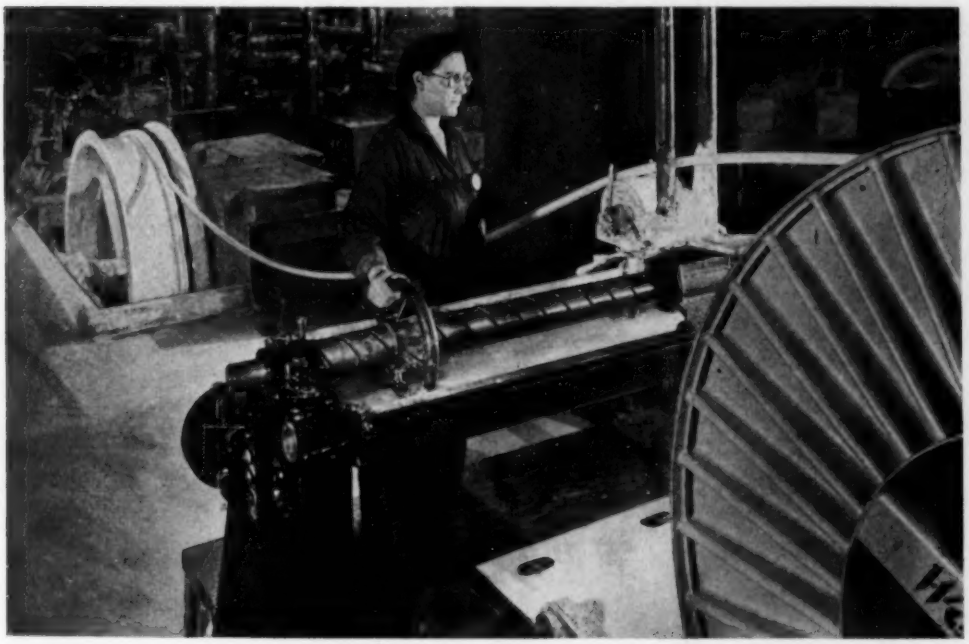
How different is the situation faced by military radio! Each army uses as many as 4,000 transmitters—and three, four, five or more armies may fight jointly on a single front. That means slicing the radio spectrum into

thousands of bits—thin bits. It also means that radio receivers, as well as transmitters, must squeeze in between the closely-packed channels and, once there, stay there. They must hold their frequency. Moreover, like soldiers, they must be capable of withstanding the hardships of battle.

Civilian radios, by comparison, lead placid lives. Usually, they occupy a comfortable corner of the living room with nothing more damaging to endure than the impact of a soft dusting cloth. They operate a few hours a day in carefully-controlled temperatures, and, with the family, share protection from the hazards of weather. The radio telephones of the armed services, on the other hand, work right around the clock.

It's not easy to build that kind of equipment.

But—getting back to that December day in 1938, and the Specialty Products manager's suitcase—the Colonel said "they" were ready. "They" consisted of a single set of blueprints for the now famed Command Set. The previous day, the Army had made its needs known, the Company's representative had done some figuring on his cuff, had telephoned his manufacturing associates for consultation, and had accepted the project for immediate production



THE JOB of distributing armored telephone cable onto a shipping reel in Western Electric's Point Breeze Works, here performed by a woman, was once work for a man who is now in the nation's armed forces

—on condition that the Army would supply finished drawings. The Army got busy. Within twenty-four hours from the time he was approached on the project, the Western Electric representative delivered the coming war's first set of working plans to Western Electric—2,300 of them stuffed in one bag!

Although the Command Set still figures prominently in the manufacturing program, it did not monopolize the "strategic" category for long. In a matter of a few months, the same sort of incident ushered in the military Radar program. This long secret and vital equipment, which through fog, rain, or the blackness of night gives our fighting men the precise location of the enemy's aircraft, ships, or similar targets by timing the echo of a radio beam, has been credited with turning the decision for the United Nations on many fronts, including the Battle for Britain.

From "Defense" to War

THE PERIOD before December 7, 1941, found Western Electric carrying its full share of the preparedness program. Army camps and naval stations were springing up everywhere and non-essential industries were being converted into defense plants, almost overnight. From Western Electric came much of the telephone and radio apparatus necessary to these centers of defense activity. But America was still at peace. It was still a "defense program."

The smoke and dust had not yet cleared above Hawaii when urgent war orders began pouring in. Needed at once were replacements for communications facilities destroyed by the Japs' attack. Switchboards, wire, cable, loading coils: all of the long familiar telephone elements of peace now became critical implements of war.

The company adopted appropriate measures to bring every resource at its command to bear directly on war production. To supplement the rapidly increasing production of its principal Works, a number of smaller factories were set up in rented quarters near these locations. New employees by the thousands, young people fresh from trade schools and high schools, farmers, department store clerks and former office workers, housewives, joined the constantly growing industrial army. These recruits replaced the nearly 20,000 men and women called to the colors and swelled the payroll to its current *75,000 plus*. These people take deep pride in the blows they are striking for victory and, in recognition of their accomplishments, the War and Navy Departments awarded them the coveted production award in 1942. They were among the first industrial groups to be so honored and six months later a star, denoting continuing excellence, was added to the Army-Navy "E" flags.

Production Multiplied

THROUGH specialized conversion, expansion, and sub-contracting, one division has increased production as much as forty times in three war-time years—and, today, hundreds of millions of dollars in Government contracts await fulfillment. In referring to the vast scale on which American industry has joined the fight, Lieutenant General Brehon Somervell,

commanding the Army Service Forces, said, on March 10, 1943: "Your achievements are of such magnitude that no single pair of eyes can see them all at once, no single mind encompasses all of them." Only a personal visit to *places* of production can give such production figures credibility.

To those who think of war work in terms of rattling rivet guns and pounding drop hammers, however, Western Electric plants may seem peaceful, almost placid. They are places where precision work counts for more than bulk and where employees know that the failure of even the smallest part can mean the difference between victory and defeat in a military operation.

The manufacturing facilities are divided into three establishments: the Hawthorne Works near Chicago, one in Kearny, N. J., and the Point Breeze Works at Baltimore, Md., together with a number of associated or "satellite" plants, whose locations for military reasons cannot be disclosed. Together, they embrace 236 acres of floor space.

WESTERN ELECTRIC's distributing houses, stocking some 10,000 different items of telephone supplies, use conveyors to speed the filling of telephone company orders, which in these days are often marked with a war-urgent "rush"

Kearny's War Story

THE KEARNY WORKS concentrates on war apparatus comprised of many small parts—sometimes as many as 60,000 in a single unit of equipment. The parts are formed by stamping, welding, soldering, molding. Then men and women war workers, like experts solving complex jig-saw puz-

zles, fit the parts together to make jacks, keys, resistances, relays, loading coils, filters, networks, lamp sockets, condensers, thermistors, and varistors. Further assembly in turn converts these into switchboards, carrier telephone systems, repeaters, and scores of other communications essentials for the Army, Navy, Lend-Lease and for war industries, defense information centers, Government offices—for the myriad agencies through which total war is waged.

Kearny is speeding production on new apparatus, developed by Bell Telephone Laboratories in coöperation with the Army and Navy. Many of these designs have emerged since the beginning of the war, while others are adaptations of peacetime equipment.

Kearny-made manual switchboards and associated equipment are in use at the fighting fronts, in outpost stations, fire control locations, and artillery observation posts. Portable central offices, much like those used in small towns all over the United States, are regularly floated ashore with landing parties of American troops during invasions. Switchboards, test sets, power panels, together with all the complex accessories needed for an efficient telephone plant, serve the posts, camps, stations, and bases of the Army and Navy. When enemy areas are occupied by the troops of the United Nations, carrier telephone equipment of the most modern design, manufactured at Kearny, moves in to furnish long distance service.

In its Vacuum Tube Shop, Kearny makes tubes for a wide variety of purposes. They range from the giants, which carry the voices of military leaders and statesmen to whole populations, to midget tubes which enable a Naval fighter at sea to make contact with his carrier base.

Hawthorne's War Story

HAWTHORNE'S WAR STORY is a twofold record of production achievement. First, it is the story of how Hawthorne's output of telephone apparatus helped prepare the nation for total war. It is the story, also, of how Hawthorne mobilized to produce highly specialized war equipment.

Today, telephone handsets no longer move along the conveyors in the station apparatus shops. Instead, the people who used to assemble such mechanisms as the receiver, transmitter, and dial for your telephone now make intricate machines which provide data for aiming anti-aircraft guns, enable ground crews to blast Axis fighters and bombers out of the sky with deadly accuracy. If the full story of how these weapons are being used against the Axis could be told, it would read like a fiction thriller.

It is no secret that from its shops come aviation radio units specifically designed for naval aircraft; radios that help American tanks smash the enemy; throat microphones for tank crews; tiny high-altitude microphones for men who, wearing oxygen masks, fight above the clouds; and field telephone sets for front-line soldiers—these are only a few of Hawthorne's many battle products.

On Hawthorne's Radar project alone, blueprints come out of the drafting department at the rate of 35,000 drawings per week to supply

the manufacturing personnel with working information on each of the more than 7,000 piece parts from which some of these complex mechanisms are assembled.

The Point Breeze Works

ESSENTIAL LINK of the telephone systems in theaters of combat, and in every war production area in the United States, is telephone cable, one of the principal products of the Point Breeze Works in Baltimore. Some months ago, in response to a rush order from the Government, Point Breeze turned out 16 miles of tape-armored cable in one fourth of the normal time. Special equipment, and zeal born of the war emergency, made *that* record.

Each week from Point Breeze have come hundreds of miles of rubber insulated field telephone wire, each reel stamped with the insignia of the Signal Corps. This wire has proved itself from Bielvmechetskoia to Guadalcanal, from Point Barrow to the Cape of Good Hope. It is the same product which was dropped recently from a bomber to speed telephone communication across a nearly impassable Alaskan glacier, and its snaky course dogged Rommel and his hordes to their defeat across the sand-swept reaches of North Africa.

WITH MANUFACTURE of telephones for civilians suspended, reconditioning of used sets is an important function of Western Electric's distributing houses. Telephones are cleaned, repaired, re-corded, and tested before being sent back to service

The men and women of Point

Breeze are turning out, on a three-shift schedule, telephone and microphone cords for the Army and Navy and terminal bases, which conserve the time of Signal Corps men in the installation of telephone cables. As in the case of both Kearny and Hawthorne, Point Breeze is also manufacturing a full quota of special electronic equipment.

The Distributing Houses

AT TWENTY-NINE POINTS throughout the United States, the Army, Navy and the telephone system have access to a chain of "general stores" where a full line of telephone goods is kept in stock to meet urgent demands for extensions or replacements to the communications network of the nation. These "stores" are Western Electric's 29 distributing houses, and an important part of the product flows through them. One or more is located in the territory of each Bell System telephone company.

The record shows that of 8,955,000 items requisitioned from these houses in a single year, more than 97 percent were furnished on the day they were wanted. Approximately 10,000 different kinds of items, ranging from machine screws to 20-ton reels of cable, are kept in stock.

In the same building with each warehouse is a repair shop. Here used apparatus is returned by the telephone companies, inspected, and reconditioned—or dismantled for the salvage of the valuable material it contains.

In addition to maintaining this essential repair service for the telephone companies, these repair shops are also channeling an appreciable amount of marginal capacity into direct production for war. As the war program cut more and more deeply into the nation's reserves of materials, with a consequent decline in the amount of supplies of telephone equipment available for civilian use, both manpower and machine capacity in many of the shops was released for manufacturing operations. Geared to war-time tempo, many shops have virtually become "sub-contractors" under the main Works. They are turning out an impressive list of war products in the amount of several million dollars annually.

The Installation Forces

NOT ALL manufacturing processes reach completion in the Works. A significant portion, on occasion, is finished at a remote site. Telephone central offices, for example, leave the factory as sub-assemblies and partially-wired apparatus. The final work of fabrication, of readying the equipment for service, becomes the responsibility of the installation department.

With all the flexibility of an army unit in the field, these installers go everywhere. For many months, parka-clad installation men have been facing the hardships of living and working in the Arctic cold side by side with the fighting men of the Army.

These men installed repeater stations along a route of 2,060 miles stretching from Edmonton, Alberta, to Fairbanks, Alaska. For the installation department, this is one of the most important jobs outside of the United States in the history of the department. In an official appraisal of their work the Army said, "out of the 184 foremen and men

who reported at this station, it would be hard to select any individual as outstanding, all having been instilled with a desire to put this job over as quickly and efficiently as possible under very difficult conditions."

While these installers were battling the ice and cold of the northern Pacific coast, others were helping the Army to transform a bleak stretch of Newfoundland wilderness into a bristling military outpost—one of the largest in the Western Hemisphere.

The enemy struck while the men were on their way to this latter job. The steamer *Caribou* which carried part of them was torpedoed and sunk by a Nazi U-boat. Three installers lost their lives during the attack.

More than 2,500 Army posts, naval stations and other vital war establishments of the continental United States, and its distant territories, today utilize the handiwork of the installation men.

WHEN expanding war industries necessitate additions to telephone central office equipment in a hurry, Western Electric installation men find themselves with a rush job to do. Here two of them are connecting cables on a switching frame

Importance of Subcontracting

DURING the first six months of 1943, Western Electric supplied the armed forces with electronic combat equipment almost equal in dollar value to its entire output of such equipment for the entire year of 1942—a production, incidentally, amounting to hundreds of millions of dollars. In

addition, it supplied significant quantities of telephones and related equipment for essential civilian services. Of this volume for the first six months of 1943, approximately 45 percent of the total was farmed out to subcontractors.

Buried in this information is a story far more important to the nation than just the indicated production, despite its impressiveness. This hidden story is one of education—of the schooling of small manufacturers in the fine art of making specialized military communications equipment. In 1938, an Army survey disclosed that fewer than half a dozen American manufacturers were qualified by experience to produce such precision apparatus of a quality adequate to meet military specifications. Today, as a result of the forced-draft teaching methods of subcontracting, that original experienced handful has grown to more than sixty firms, all of which now accept prime contracts from the Army and Navy and, in turn, subcontract projects on their own.

Altogether, production from more than 1,300 manufacturers flows in part into the war through Western Electric, and the Company does business with more than 13,000 subcontractors and suppliers. A listing of their addresses covers the nation from coast to coast. They include little organizations with fewer than fifty employees and big ones whose personnel is counted by the tens of thousands.

As a result, some of the vital parts now assembled in Western Electric equipment originate in rather incongruous surroundings. One former manufacturer of marbles, for example, now makes precise glass parts for Command Sets. A firm which in peacetime specialized in bathroom accessories now turns out close tolerance tubing. A former maker of hairwaving machines is producing precision machine parts and jack assemblies. Perhaps the oddest of all is the one-time maker of doll's eyes, and voice-boxes which say "mamma!" This manufacturer now makes a real contribution to a vital electronic instrument. But, on second thought—and running him close competition—is the man who gave up the production of embalming fluid to help the Company make gun directors.

WHAT, with the help of these manufacturers, is made? Here is a partial list of the leading products:

RADAR. Radio-detecting-and-ranging sets which spot enemy planes or ships many miles away through darkness, clouds, and fog to give accurate bearings on their location and speed.

RADIO COMMAND SETS. Commands from ground stations and between planes are flashed over these compact, two-way instruments.

TANK RADIO SETS. Like the men who drive and fight our "land battleships," these sets must be tough to take the rough going. They bring every tankman within earshot of both his commander and his comrades in arms.

FIXED RADIO TRANSMITTERS. Powerful radios which weave a world-wide web of communications essential to the successful prosecution of global war.

VACUUM TUBES. Heart of all electronic equipment, vacuum tubes are doing an all-out war job. As many as 70 tubes may be used in a single unit of equipment, with

several times that number on hand for replacement.

QUARTZ CRYSTALS. Sentries of the airways, these wafer thin crystals confine both transmitters and receivers to their assigned place on radio dials—and keep them there. One shop of Western Electric now makes as many crystals in a day as the whole industry used to turn out in a year. And *four* such shops now work around the clock. Volume production methods have lowered the price to the Government of crystals to about one-twentieth of their former price.

TELETYPEWRITERS. In the Chicago plant of the Teletypewriter Corporation, a Western Electric subsidiary, these essential machines are being manufactured on an intensified schedule almost exclusively for the Army and Navy.

FIELD TELEPHONES. Wherever American troops fight on land, there you will find these durable telephones with their snug cases, prepared to coördinate the action.

HEADSETS. An ingenious adaptation of the hearing aid receiver, these effective units are worn inside helmets, free a soldier's hands for battle. They are used for communication in every branch of the service.

MICROPHONES. Their variety is legion: high altitude, moisture-proof, sound powered, throat—each designed for maximum performance on its particular job.

SOUND POWERED TELEPHONES. The basic intercommunicating system used on all U. S. Naval vessels. These instruments require no power supply—keep on going when other communications systems fail.

BATTLE ANNOUNCING SYSTEMS. Aboard fighting ships, every quarter of the vessel is brought within speaking distance of the commander by these "high-volume" systems.

GUN DIRECTORS. Intricate mechanisms which instantly solve complicated mathematical problems involving such factors as range, speed, wind velocity, and atmospheric pressure, enabling our gunners to hit fast-moving targets miles away.

TELEPHONE APPARATUS, WIRE, AND CABLE. Backbone of the war's communications network is the conventional telephone system. Before any major decision, any strategic move of importance, can be resolved on the fighting front, the telephone lines of the United Nations must first play their critical role in coördination. Fortunately, these telephone systems, including the Bell System, were largely built before the war, and built well. In comparison with the vast size of the telephone plant, the dribble of replacement parts essential to its continued operation is insignificant. But such replacements and extensions as are essential assume tremendous importance. Western Electric continues to devote a portion of its manufacturing capacity to this critical type of work.

BERNARD BARUCH once said that a nation intent on waging a victorious war should so order its national life as to admit of no other thought or action; that it should work and fight and plan as if the war were destined to last forever. That describes Western Electric's approach to its present job. The war comes first—and there is no second.

It is a grim policy and Western Electric people take no pleasure in manufacturing machines for war. But faith in the victory to come is part of the blood and bone of every American. With the arrival of peace, the Company has its job cut out for it—telephone making, long curtailed, to bind the nation and the world together in a system of communications more inclusive than any we knew before the war.

Of 15,000 Bell System Men in the Signal Corps, Nearly 5,000 Have Been Distributed in 380 Specially Selected Units by Means of the Coöperative "Affiliated Plan"

Skilled Manpower for the Signal Corps

Donald S. Bridgman

THERE ARE TODAY over 50,000 Bell System men and women in military and naval service, of whom more than 35,000 are in the Army and the remainder in the Navy, Marine Corps, and Coast Guard. Of those in the Army, about 15,000, or over 40 percent, are in the Signal Corps —although its total personnel is roughly only 4 percent of the entire Army.

This concentration of System employees in the Signal Corps arises, of course, from its special responsibility within the Army, which was recently summarized by the Assistant Chief Signal Officer, Major-General James A. Code, Jr.:

> "The Signal Corps is responsible for the effectiveness of all communications of the Army, whether the message is from a Field Artillery observation post to its battery, or from a fighter pilot over the South Pacific to another pilot in the same formation, or from the Chief of Staff in Washington to the commanding general of the European theater of operations. It is the unifying agency, developing and procuring the equipment, prescribing the tactics and the techniques of its use, and acting as advisor and consultant on all phases of communications to all commanders through all echelons of command."

The Signal Corps is a component of the Army Service Forces, as are the Ordnance Department, Quartermaster Corps, Engineer Corps, and other organizations which serve the Ground Forces and Air Forces in the field. It operates the War Department's Communication Center in Washington and a vast network for

Army communications covering this country and reaching theaters of operations in all parts of the world. In those theaters, Signal Corps units install and operate the communications systems to every division headquarters and every Army air base.

Although provided by the Signal Corps, the communications equipment used by regiments and smaller tactical units in combat zones is operated by the personnel of the particular arm involved. On this account, many of the Bell System employees in the branches of the Army other than the Signal Corps have been assigned to communications duties and are effectively utilizing their telephone experience. This would be true, also, of those in the Navy, Marine Corps, and Coast Guard. Whether in such assignments or not, all are playing their part.

Of the 15,000 System employees in the Signal Corps, nearly two-thirds entered the Army through selective service or enlistment, and have found their places through the usual channels of assignment and promotion. Their large number has been mainly due to special arrangements for the assignment of as many experienced telephone men as practicable to Signal Corps replacement centers. The record indicates that the background and ability of these men have made great contributions to the work of the organizations in which they are. Several hundred were called to active duty as members of the Officers Reserve Corps or National Guard, and brought to their assignments a combination of telephone experience and substantial military training which in many instances has proved of notable value.

The "Affiliated Plan"

THE SIGNAL CORPS, however, was not willing to depend solely on these normal ways of securing trained communications men in the event of war. More than two years before the attack on Pearl Harbor, it had worked out in coöperation with the Bell System the special plan through which nearly 5,000 additional telephone men, usually of several years' service, volunteered for specific Signal Corps positions, were recommended by the System companies in which they were employed, and were selected as qualified for those assignments.

The plan through which these men entered the Army has become known as the "Affiliated Plan," and is an outgrowth of experience gained in the first World War, when the knowledge and skill of trained telephone men first proved invaluable to the Signal Corps. Forty-six hundred of the 25,000 Bell System employees who served in that struggle were enrolled in Signal Corps units; more than half of them were concentrated in 12 telegraph battalions, each of 216 officers and men, recruited in full from volunteers from a Bell System company. Two radio companies of field signal battalions were entirely composed of volunteers from the Western Electric Company.

These organizations all saw extensive service in France, where some served with the combat forces at the front and others were engaged in construction, maintenance, and operations in the zone of communications behind the lines. After the Armistice, General Pershing spoke of the work of the Signal Corps and of the experienced communications

men in its ranks as one of the greatest accomplishments of the American Expeditionary Forces.

As the tension in Europe became more and more severe during the late 1930's, and as War Department plans here in the United States were formulated to meet any possible emergency, the Signal Corps again requested the American Telephone and Telegraph Company to consider the development of a procedure through which it might use even more effectively than in the first World War the experience and knowledge of men from the System companies. At the same time, it wished to make certain that the extent of its demands for such men would not severely handicap the System in providing within this country the rapid communication service so essential in time of war.

Recognizing the importance of the problem, the American Company worked with the Signal Corps to develop a suitable tentative plan. This was approved by the War Department, and was discussed with the other System companies. The plan was then laid on the shelf—for use only in the event of war.

A few months later, Germany attacked Poland; and before a year had passed, Norway, Holland, Belgium and France had fallen. The

Communications Specialists Cadre

Signal Battalion—Ground Forces

No. of Men	*Army Grade*	*Occupational Designation*
1	Captain	Construction Company
1	Captain	Operations Company
1	1st Lieutenant	Motor Transp. Specialist
2	1st Lieutenant	Construction Specialist
1	1st Lieutenant	Message Center Specialist
1	1st Lieutenant	Wire Operation Specialist
1	1st Lieutenant	Inst. & Mtce. Specialist
2	2nd Lieutenant	Construction Specialist
1	2nd Lieutenant	Inst. & Mtce. Specialist
2	Master Sergeant	Line Foreman
1	Master Sergeant	Chief Telegraph Printer Operator
1	Master Sergeant	Wire Chief
1	Technical Sergeant	Asst. Line Foreman
1	Technical Sergeant	Asst. Chief Tel. Printer Operator
1	Technical Sergeant	Assistant Wire Chief
1	Technician—4th Grade	Insideman
1	Technician—4th Grade	Repeaterman
2	Technician—4th Grade	Switchboard Installer
2	Technician—5th Grade	Frameman

January, 1942

blitzkrieg demonstrated again and again the indispensability of superior communications for this new kind of war.

As the danger to the United States increased, the Signal Corps requested that volunteers be sought for certain commissioned officers' positions in six Signal Battalions, so that they might receive some preliminary military training and be ready to serve in case war were suddenly declared. Each of six System companies promptly found the men needed for one of these units and, some months before the Japanese attack at Pearl Harbor, these men received several weeks' training at Fort Monmouth.

Immediately following that attack, the preliminary plan was revised to meet the Signal Corps' needs under the new conditions and, within a few weeks, it was put into operation. One of the principal changes required was the inclusion of a substantial number of units to serve with the Air Forces, in view of the great importance of their communications problem.

The essential element of this plan was the designation of a communications specialists' cadre to form a nucleus of experienced telephone men within each of a large number of Sig-

PHOTOGRAPHS FROM U. S. ARMY SIGNAL CORPS

SWITCHBOARD OPERATOR and plotter receive telephoned instructions during an anti-aircraft demonstration at an American desert training center

nal Corps units. The accompanying table lists the positions designated for such a cadre in a Signal Battalion in the preliminary plan, when the total strength of that organization, except its Medical Detachment, was 20 commissioned officers and 542 enlisted men. It illustrates the application of a scheme to an important Signal Corps organization. This method, by placing a relatively small number of experienced men in each unit selected, insures the effective use of their knowledge and skill, and is far more economical of trained manpower than would be true if an equal number of men were concentrated in fewer units.

THE PROGRAM submitted to the System companies by the Signal Corps within a few weeks after Pearl Harbor called for about 400 officers and 1,150 enlisted men to be placed in 160 affiliated units, and about 50 men for staff positions in the office of the Chief Signal Officer.

As the scope of the conflict made ever increasing demands upon the Army, the Signal Corps added to its requests; and by the end of the year, the System companies had submitted accepted candidates for about 700 commissioned and 2,300 enlisted positions in 200 units, for 74 staff positions in the office of the Chief Signal Officer, and for 200 Post Signal Officers at Army air bases. In addition, some 150 candidates submitted for commissioned officers' positions under the "affiliated plan" had received other appointments within the Signal Corps.

The total number of men appointed or enlisted, therefore, exceeded 3,400, although 200 or 300 of them were not called to active duty until 1943. This year the requirements are distinctly smaller, as the Signal Corps' own training facilities became better equipped to meet its demands; but by this fall, about 150 additional officers and 1,100 enlisted men assigned to 180 units and to a number of technical staff positions will have entered its ranks through this plan.

In carrying out the plan, the Signal Corps, in consultation with the Ground Forces and Air Forces of the Army, with whom the great majority of the Signal units serve, designated the particular units which were to contain an affiliated cadre of Bell System men and the composition of those groups. The list of units, their probable activation dates, and the organization tables of the cadres were then submitted to the A. T. & T. Company, which in turn canvassed the several System companies as to the numbers and types of units for which they might be able to secure qualified volunteers. The companies then have notified their employees of the available positions for which they might apply, and qualified applicants have been recommended and their applications forwarded to the Signal Corps.

In the case of candidates for enlisted positions, the Signal Corps reviews the experience shown upon their application blanks with relation to the Army specifications for the positions involved. It then requests the enlistment or voluntary induction of acceptable men who prove physically qualified, under a procedure similar to that used for air cadets and other candidates for specialized training. These men become members of the

Enlisted Reserves and return to their work until called to active duty upon or shortly before activation of their units.

Candidates for appointment as commissioned officers must conform both to maximum age limits set as appropriate for the grade and type of duty expected and to minimum limits defined by War Department policy for appointment from civil life, which may be relaxed only for particular types of education and experience. Their personal qualities and capacity for leadership are appraised through interviews conducted by designated Army officers. Their education and experience are matched against the specifications established for their proposed assignment, and the level of their position in the business is compared with the grade for which they applying. The results of their physical examinations are reviewed by the Surgeon-General's Office. All of these factors are then considered by a Signal Corps Board of Officers, and during the past year the appointments which it approves have been reviewed by a special Personnel Board established for the entire War Department.

UP GOES a telephone line amid Tunisian ruins as a member of a Signal Battalion helps to restore communications

Although it was recognized that the great majority of the men accepted under this plan would not have previous military training or experi-

ence, in the months following Pearl Harbor it was often necessary to call them to active duty directly with their units or to provide only short intensive training with similar units already in advanced stages of preparation. This procedure placed a special burden upon officers required to take immediate responsibility for a group of men of whom some might have had several months of military duty.

To overcome this difficulty, since the fall of 1942, when the training facilities available first made it possible, all "affiliated plan" officers have been sent to the Eastern Signal Corps School at Fort Monmouth for nine weeks of basic military training and special training for officers. More recently, all enlisted personnel has been given four weeks of basic military training in the Central Signal Corps Replacement Training Center at Camp Crowder.

Both officers and men then are given further training in a well established parent unit of the same type as that to which they will be assigned permanently. In this way they are fully prepared for the activation of their own units and the more advanced training and maneuver experience they will receive in them.

Units of Many Kinds

AMONG THE 380 affiliated units previously mentioned is almost every type required in the operations of the Signal Corps. Some are responsible for the construction of major communication lines in base areas, others for the operation of the extensive communications systems reaching out from the headquarters of a theater of operations, and still others for both operations and the light construction needed from hour to hour close to a rapidly shifting front. A few have established supply depots and repair shops for communications equipment at ports of embarkation or debarkation and have maintained and operated the local communications systems there. A large number have set up and operated fixed or mobile supply and repair depots at other points selected as major centers of distribution or as those suitable for the use of combat forces in the immediate vicinity.

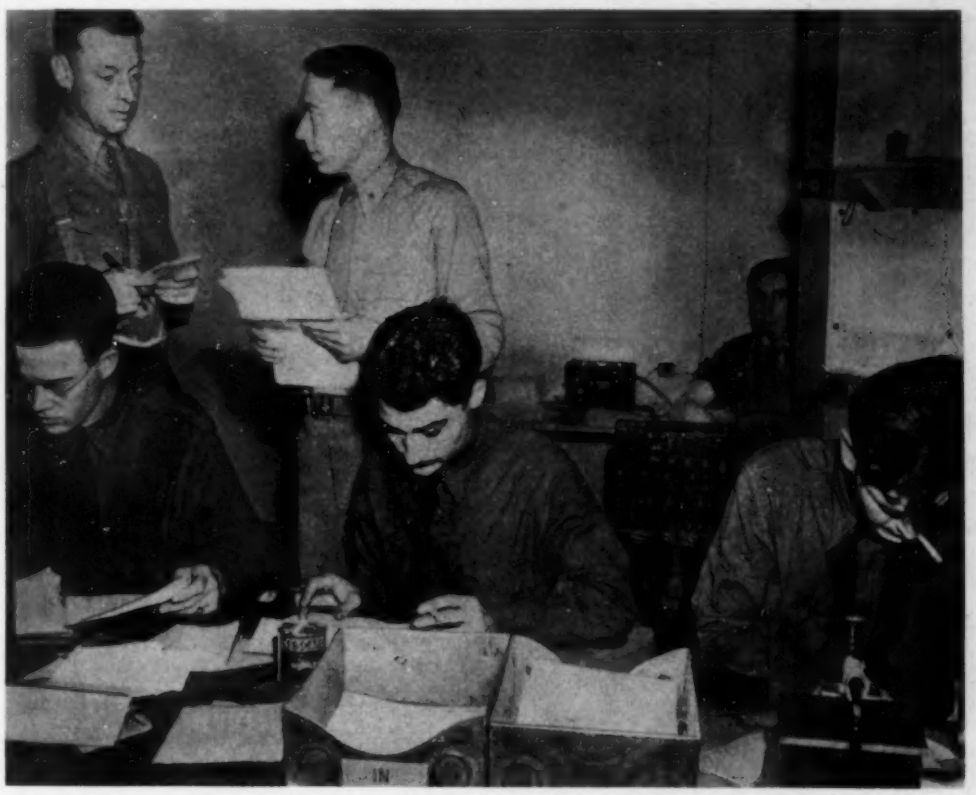
Units of all these types are attached to the Army Service Forces or the Ground Forces and, in many instances, units with similar functions are serving with the Air Forces. Some of the units with the Air Forces have assisted in the development of the far-flung aircraft warning system within the United States, while many others have established and operated communication systems at advanced air fields in combat zones. Of all the units, about four-fifths are serving with the Air Forces; but since the affiliated cadres of those with the Ground Forces generally are much larger, the total number of affiliated men in the two groups is about equal.

Just as there are many types of affiliated units, there are also many locations throughout the world to which have been sent those whose preliminary training is complete. Obviously these locations cannot be closely identified, but they include bases in the Caribbean and Atlantic areas, points in northwest Canada and Alaska, islands in the southwest Pacific, and centers of military activity in Australia, the Middle East, and many parts of northwest Africa.

As this is written, three weeks after the landings in Sicily, some units undoubtedly are helping to establish the communications essential for the rapidly advancing American forces there.

Only after victory is won can there be told the most interesting and important news about these units and the telephone men in them: the story of hardships, tough problems demanding expert knowledge and skill for solution, and achievements based on both experience and the qualities of a soldier. At present only a few scattered examples may be given.

The affiliated cadre of the first unit called to active duty reported at Fort Monmouth on February 28, 1942, and less than three weeks later proceeded to the West Coast, where the entire unit was activated. Soon afterward, it received intensive training in desert warfare when, as one maneuver problem, it built an open-wire pole line across the Mojave Desert and helped to develop a number of construction methods adapted



THE MESSAGE CENTER of Army field headquarters is one of the busiest offices in the Alaskan theater of operations

to such conditions. Among these was the use of a special plow for burying field wire, developed by one of the master sergeants in the unit. The training obtained by these men proved so valuable that a number of the affiliated officers and men have been transferred to other units where

THIS IS the "field office" of a Signal Company Captain somewhere in New Guinea

men of their background have been particularly needed. The unit itself is now overseas.

The affiliated cadre of another early unit was called to active duty in April, 1942. Five months later, the Associated Company from which it had come was asked to replace the entire enlisted group—as seven of the original twelve men had been selected for Officers' Candidate School and five had been transferred to other duties. A week after the new men reported, the unit was on its way to the Southwest Pacific area, where it has won the commendation of higher officers for the effective discharge of many difficult assignments—including the construction of several badly-needed pole lines and the rapid installation and testing of the radio sets in eight newly-assembled jeeps needed for a special mission. Within the last few months, nine more men in the unit from the telephone company providing the affiliated cadre have been selected for Officers' Training.

On Many Fronts

THE TERRAIN, climate, and lack of transportation on the Southwestern Pacific islands lead to the most extreme difficulties in the establishment there of any sort of wire communications. On one island, a pair of wires was strung for 130 miles by a Signal Company, but 32 horses were killed in doing it. In another instance, wire was placed on trees across forty miles of water-covered bog where the mud was too deep for a man on foot and the water too shallow for a boat—so both methods of progress were used.

In much of the jungle, men are fortunate to get through the undergrowth with a trail of waterproof wire. There is no chance to string it, and naturally no place for underground cable. Although radio is used for inter-island communication and to reach the most advanced battle positions, it serves as a homing beam for the enemy and its increased use may give advance warning of

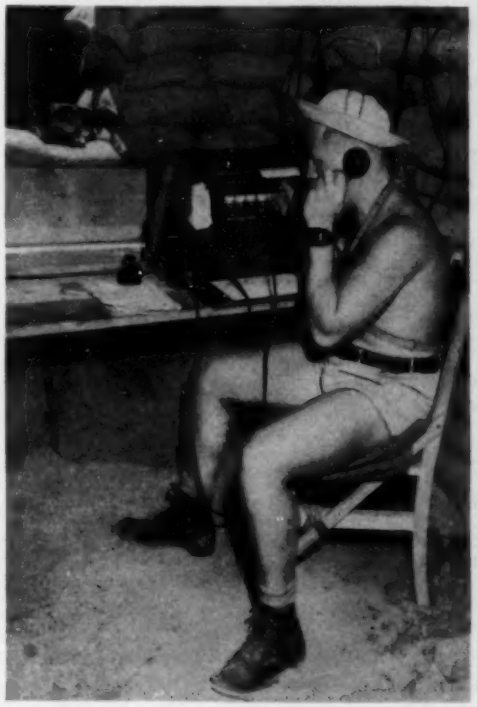
military action. Telephone wire, therefore, is strung right up to the front lines and frequently this is done by Signal Corps men who actually become combat troops.

Among the many Bell System men both in and outside of the Army who have contributed to the construction and installation of the Alaska Communications System along the Alcan Highway have been those in the affiliated unit responsible for the maintenance and operation of that system, with its open-wire carrier circuits over 2,000 miles long. They have experienced the cold and storms of the region and have struggled with problems presented by hard frozen ground and swampy muskeg, automatic cut-outs on motor generator sets in overheated tiny arctic huts, and the mountain glacier across which a line was built with ten reels of wire dropped from an Army bomber at the suggestion of a Signal Corps Lieutenant.

In North Africa

IN NORTH AFRICA the Signal Corps met, for the first time in this war, all the communications problems of an offensive involving large forces, intensive aerial activity, and the use of mechanized equipment covering long distances at great speed. A new theater of operations, thousands of miles from the major sources of supply, had to be established, and the special difficulties of rugged mountains and burning deserts had to be overcome. Here Signal Corps units, working against time, installed large switchboards at theater and army headquarters, often without complete drawings or equipment, substituting other items for standard ones that had been lost or delayed, and set up smaller boards at command posts near the front.

Although the French open-wire lines were an important factor in establishing communications in the area, many of them had to be repaired and new cross-arms and wire added. Both French and American cross-arms, hardware, and wire were used on these lines.



SOMEWHERE in Australia, this is an important part of an American aircraft warning unit

In addition, the construction forces built a number of completely new fixed lines, both overhead and underground, and set up many miles of rapid pole-line construction, which substitutes two by fours for poles.

Sometimes this work was carried on under enemy artillery fire or dive-bombing attacks. At least one construction unit added the task of picking up land mines to that of line construction following a German retreat near Gafsa in March.

One of the Signal Corps' achievements in North Africa was the fine air-raid warning system quickly established there. This effectively spotted the enemy planes while they were still many miles away and enabled our air forces to drive them back, usually before they could attack major installations or troop concentrations.

Another achievement was the provision of adequate communications equipment and supplies where they were needed by both the Corps itself and the communications personnel of combat units. This required careful estimates of demand and energetic efforts of key personnel at every stage of distribution. The final stage frequently involved establishment of signal supply dumps not far from the front lines, where units in the area generally called for their own supplies. At one such dump, shipments averaging ten tons daily were handled by a depot unit of one officer and fifteen men. British as well as American officers in North Africa commended the excellence of our signal equipment, which stood up to an unprecedented degree under the conditions of desert warfare.

THE CHARACTERISTICS of Signal Corps operations in this theater are vividly portrayed in the following extract from the report of an officer:

"As I dictate this letter in our field set-up here in the woods tonight, we are in the midst of a mobile, fast moving operation with a very fluid front. This operation might be compared to a football game where the Corps Command Post is in the position of quarterback, well back of the line of scrimmage, directing a play with its full force on one end of the line; and then, without waiting to call a new set of signals, the play is suddenly shifted to the extreme opposite end of the line—some dozens of miles across from end to end.

"At the moment, the Corps Wire Officer is making his shifts of circuits by a series of telephone calls to various key points where, with the aid of an interpreter, he hopes to switch over the connections necessary to insure telephone and telegraph service at the other end of the lines for the major units within the next three hours. The Corps Radio Officer is also at the phone arranging details to cover emergency radio communication on one end of the line where the enemy has suddenly withdrawn and where communication at the moment is rather uncertain, since wire installations had not been entirely completed.

"Corps radio, wire, teletypewriter, and message center teams are moving at this moment to the other end of the line, to an advance Corps signal center being established there from which we will give more detailed instructions to the teams later tonight as the tactical plan unfolds. Our message center people are planning the revision of their scheduled messenger runs to take care of the new developments. By midnight we hope to have both ends of the line well in hand.

"Such a change of tactical plan in-

troduces new controls as units normally operating under division control suddenly revert to Corps control while still in the field of battle, and units under Corps control switch to division control. The very few open wire commercial circuits available must be assigned to all the different services in the area. Since all circuits are always in use, this presents a tricky wire problem. This office controls the assignment of all commercial long line facilities in our area of operation."

Bell System men in affiliated units played a part in all the types of activities mentioned. They share in the high tribute paid at the close of the campaign to all Signal Corps men there by General Sir Harold R. L. G. Alexander, Deputy Commander under General Eisenhower and in charge of all ground operations, who said, "The victory is of your making, too, and its fame and glory belong to each one of you."

Men in Staff Work

THE AFFILIATED OFFICERS appointed to staff positions in the office of the Chief Signal Officer are carrying on a great variety of activities, ranging from the development of new wire and radio equipment to responsibility for supervision of all office service work in the Signal Corps' Washington headquarters. The problems with which they are concerned include study of the requirements for critical materials in the manufacture of signal equipment; analysis of the relative urgency of the needs for different types of this equipment and of those needs in our Army, our Navy, and the allied nations; and development of programs to insure that all

AN UNDERGROUND radio station is being set up at a newly established American airfield in North Africa

the equipment needed for particular purposes is shipped on time and is so distributed in convoys that losses are minimized if ships are sunk.

Other officers in this group are concerned with the training and personnel problems of the Signal Corps, are responsible for appraisal of the organization and operation of their divisions, or are acting as executive officers for them. A few have been assigned to special field duties. At least two have made extended inspection trips to bases and theaters of operation. One of these trips involved eight weeks in Australia and the Southwest Pacific to determine just what equipment and supplies were needed for the fixed communications systems in that area and to assist in planning for their movement.

THE MORE THAN 200 Post Signal Officers appointed under the "affiliated plan" for duty at Army air bases all were given a special training course nine weeks in length at Fort Monmouth, and generally have been at their stations too short a time for news of unusual activities to be received from them. Their duties involve general coördination of all communications work at the air base, including procurement of signal equipment, maintenance of the local communications system, and operation of the message center.

Although most of these men undoubtedly still are at bases in this country, a number have been sent abroad to those in theaters of operation. A few have been diverted to other assignments because of their special background and unusual needs for men of their type. One is concerned with studying the personnel requirements and commissioned officer assignments in one of the five principal divisions of the Office of the Chief Signal Officer. Another is responsible for difficult land-line and submarine cable construction work at a base in the Caribbean.

Each man with whom it has been possible to discuss the challenge of his work in this war has emphasized flexibility and the capacity for rapid adjustment as the most important element for success in meeting that challenge. New and difficult environment, new types of work, new problems, the lack of familiar tools and supplies, have all made this quality essential. On the whole, there seems reason to believe that the Bell System men who have volunteered under the "affiliated plan" have possessed much of it, and their solid foundation of telephone knowledge and skill has given them the chance to exercise it.

Although the proportion of enlisted men selected for officer candidate school from the unit already mentioned undoubtedly was exceptional, the substantial number of such selections from the units generally and the frequent promotions among both officers and enlisted men in the affiliated cadres are evidence of their calibre.

The Plan's Values

NO ONE can predict what may be necessary to win this war. But it seems probable that the men already enrolled under the "affiliated plan," together with those who have entered the Signal Corps in other ways, will provide it with much of the special experience and skill required. Future increments in its force should come principally through selective

service into the outstanding chain of training schools it has established. There may be special needs for men familiar with particular types of telephone equipment, but the numbers involved are likely to be a fraction of those of 1942 and 1943.

To the group of men now on duty, every Operating Company, the American Company's general staff, the Western Electric Company, and Bell Telephone Laboratories have contributed. Although not included in the numbers given, the independent telephone companies connecting with the Bell System have provided men for the cadres of a good many additional units. Within the System, the number of volunteers with the necessary experience who could be spared naturally has varied from company to company with the pressure of service needs from war industries and military camps, but each has done its share.

No true estimate of the worth of the plan may be given until victory has been won, but some of its values may be suggested even now. For the System companies, it has meant that the science and art of communications built out of sixty-five years of experience and effort could be effectively shared in the defense of the nation, while its loss of highly skilled personnel did not seriously injure their big war job at home. To the men came the satisfaction of using all they had of knowledge and skill to the best advantage in the cause for which they offered whatever might be required of them.

Of the plan's value to the Signal Corps, after the first year of its operation, the Chief Signal Officer of the Army wrote as follows:

"The situation a year ago placed great responsibility upon the Signal Corps. A large share of this responsibility fell upon the communications industry, which, when called upon, came forward without hesitation to supply the highly skilled individuals to serve where their special abilities would be of maximum value. The men who have volunteered their services to the Signal Corps in an effort to make our country stronger and safer, are to be congratulated for their unselfish and coöperative spirit. These men are setting an enviable record which is both a credit to themselves and to the American Telephone and Telegraph Company and the subsidiaries.

"The splendid qualifications of your employees who have entered the services of their country indicate the excellent training they have previously received through the years of affiliation with the Bell System. This was the calibre of man the Signal Corps needed in order to place in operation the units now fulfilling their duties in various theatres of operation and in the Continental United States."

THE BELL SYSTEM is proud to have that statement and proud of the men who have won it by their ability, their grit, and, when necessary, their lives. Yet these "affiliated plan" men and the other System employees in its ranks are a small part of the Signal Corps. They acknowledge their debt to its top leadership, its officers and enlisted men from the Regular Army and reserves, and its other new recruits. They salute the magnificent job the Signal Corps has done.

Cables, Switchboards, Other Equipment—Mainly Salvaged and Reconditioned—Are Held at Strategic Locations to Restore Service in Case of Sabotage or Enemy Damage

War Emergency Stocks in the Bell System

John W. Campbell and Linus E. Kittredge

WHEN STORM, FLOOD, OR FIRE destroys communication facilities, reserves of material must be quickly available to permit the prompt restoration of service. In peace-time, it has been the experience of the Bell System that it can meet such material requirements by temporarily depleting the central stocks of wire, cable, and other plant items which the Western Electric Company, the manufacturing and supply unit of the Bell System, maintains to fulfill the regular day-to-day needs of the construction and maintenance operations of the System's Associated Companies.

If the emergency is very great—as it was, for example, in the New England hurricane of 1938—the supply forces fall back on other lines of defense. They draw on the materials intended for construction projects which are under way in other parts of the System. They also secure materials in process of manufacture: not only outside plant but, if it is required, central office equipment as well. These are rushed through to completion and diverted from their intended use in order to meet the particular requirements imposed by the emergency.

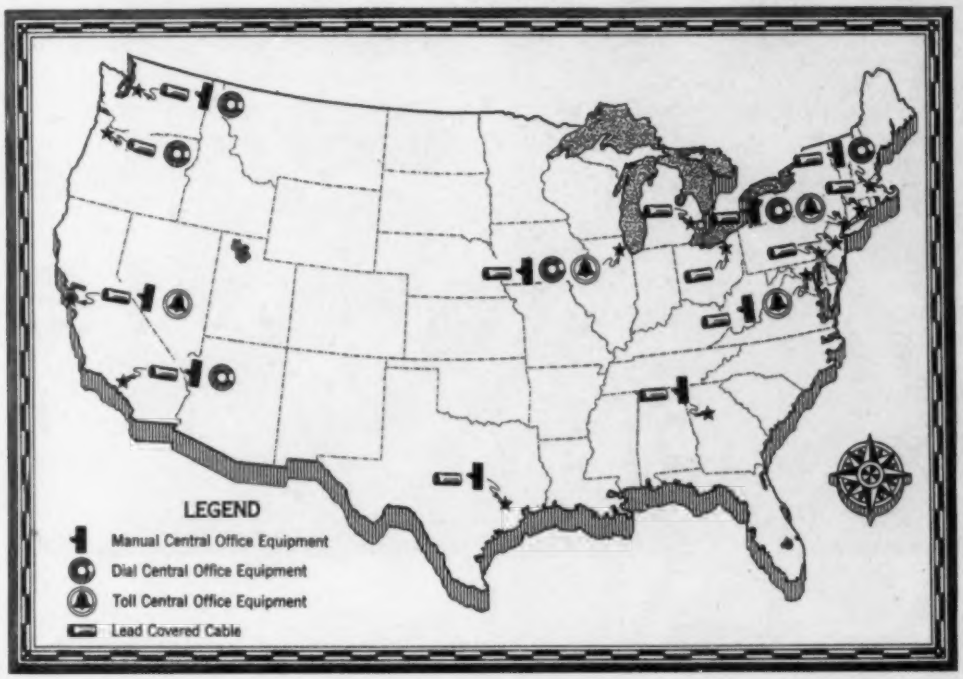
Thanks to standardization, materials derived from these various sources, wherever they may be in the Bell System, form a pool which can be drawn on as necessary to meet a crisis anywhere. Experience over the years has amply demonstrated the System's ability to cope with the most severe peace-time emergency needs.

In war-time, the picture changes. Stocks of materials are shrunk, in

keeping with the lesser requirements of a sharply reduced construction program and the necessity to conserve critical materials. For example, measured in terms of the materials required, the programs of additions to exchange cable and central offices in 1943 will each be only about 5 percent of the 1941 programs. Correspondingly, the amounts in the central stocks, the volume of materials delivered to the field awaiting installation, and the volume in process of manufacture have undergone sharp reductions. Instead of manufacturing equipment for the Bell System, the Western Electric Company has turned largely to the production of war materials.* In short, for many categories of materials the normal peace-time reserves are no longer available to meet emergency requirements.

In time of war, communications companies have to be ready to repair damage not only from the attacks of the elements but also possible attacks from other sources: sabotage and enemy action. Again, materials are required, but materials of a different character.

The Battle of Britain demonstrated that central office equipment and large-size underground cables, which are not likely to meet with concentrated heavy damage during peace-time, are the very types of telephone plant most likely to suffer under bombing attack. It became ap-



STOCKS OF CABLES and central office equipment are held at strategic locations

* See "Allo Maroc!" page 149.

parent in the spring of 1942 that, with the prospective rapid drop in the construction and manufacturing program, materials in process would soon cease to provide an adequate source from which to meet possible demands for war emergency material, and that some special means must be set up to provide a pool which could be drawn on in the event of destruction of telephone plant as a result of war.

READY FOR IMMEDIATE SHIPMENT by truck or rail: part of the 300,000 feet of used lead-sheathed telephone cable, inspected and tested, which is stored at locations in various parts of the country

After discussions between staff members at A. T. and T. headquarters and a number of the Associated Companies, it was decided to set up a war emergency stock of exchange underground cable and of various types of central office equipment amounting in total to about $3,000,000. Because of the critical material and manufacturing situation, every effort was made to obtain these stocks from used materials. As a result, it has been found possible to provide about two-thirds of the total stocks, in terms of dollar value, by the use of salvaged plant reconditioned as necessary.

In view of the unusual purpose of the war emergency stock—solely to provide a form of insurance against enemy action which might take place anywhere in the System, and to have a common integrated pool of cable and equipment which can be thrown into the breach wherever it may be required—the decision was reached to have the American Telephone and Telegraph Company purchase and own these materials, but to distribute them strategically throughout the country at locations which would make them available to all with minimum delay in the event of need.

The broad outline of the plan for a war emergency stock which the Bell System proposed was concurred in by

the Communications Division of the War Production Board in July, 1942. Prior to its formal approval by the Board and the granting of the preference ratings required to cover certain necessary purchases by the A. T. and T. Company, engineers from the Associated Companies and from the headquarters group worked out the details of the large number of items of equipment and cable—used material so far as practicable—to be transferred to the war emergency stock: a nice problem of providing the maximum amount of insurance with the minimum of those materials falling in the critical category.

THE FORMAL APPLICATION was granted by the War Production Board on March 10, 1943. With minor exceptions, the stocks are now definitely stored at the selected locations and ready for immediate use. Since the Western Electric Company has facilities and trained personnel to handle the disbursement and transportation of materials such as these under emergency conditions, the stocks have been placed under the custodianship of that organization. As requested by the War Production Board, the stocks will be available to any telephone company, Bell or independent, in the event of need arising from war damage.

If an emergency stock is to fulfill its purpose, it is necessary not only that the stock should include the materials needed but, of almost equal importance, it must be known exactly where each item is: not only what you have but where you have it. Detailed records have been set up at System headquarters, and also placed in the hands of the Western Electric Company and the Associated Companies of the System, giving the location and exact make-up of each item of manual and dial central office equipment, each unit of power plant, each reel of cable, each essential piece included in the emergency stocks.

CLEARLY MARKED on the inner surface of the reel, each section of cable can be quickly identified as to length, make-up, and condition

Particular attention has been given to so packaging and storing the materials that those which would be required first can be started on their way to a scene of damage as soon as word is received as to what to send and where to send it.

In the map on page 179 are indicated the locations of war emergency stocks of cable and equipment. The reasons for the concentrations along the coastal fringes and in the busiest war industry areas of the Great Lakes region—as well as for indefiniteness of the locations on the map—are probably self-evident.

Emergency Cable Stocks

A TOTAL of about 305,000 sheath feet—nearly 60 miles—of non-quadded exchange cable, ranging in size from 300-pair 19-gauge to 1800-pair 26-gauge, is on hand. The distribution of the emergency stock among the different sizes and gauges of cable follows the broad pattern of the working exchange underground cable it is designed to protect; but since the cable included in the pool was restricted to such used cable as was available, it was necessary in some instances to vary somewhat from this ideal distribution if the desired total length of cable was to be secured. The cable included in the emergency stock was not only subjected to careful visual inspection but to rigorous electrical tests, and to gas pressure tests for sheath condition, in order to insure its immediate availability for use.

It was not considered necessary to include in the stocks small-size cables of the type used for aerial distribution, since such cables are not concentrated in heavy common runs, as are many of the large-size exchange underground feeder and inter-office trunk cables; and for the further reason that these small distribution cables are generally so located as to be readily accessible and therefore lend themselves to patching or piecing out in the event of damage. Also, even under present conditions, the working supplies of the telephone companies and the Western Electric Company of these small-size cables would be adequate for the repair of a considerable amount of damage.

Neither was any toll cable included in the emergency stock. This omission was in part because toll cables are not so concentrated as are exchange cables. Moreover, because of their great variation in size, type, and design, it is normal procedure to stock sizable amounts of toll cables for the emergency restoration of service, including both lengths of specific cable and also an all-purpose quadded emergency cable designed for general use for quick restoration of toll circuits.

British experience was important among the things which were considered in reaching the decision to confine the war emergency cable stocks to exchange cables of the larger sizes. A report on a major telephone plant restoration in London following a bombing attack in December, 1940, appears in a British technical journal received at the time this article was being prepared. This report provides further evidence that large size exchange cables and central office equipment represent the material items most needed for prompt service restoration after a bombing attack. Because of the scarcity of materials, Bell System engineers naturally wished to limit the war emergency stock of cable to the minimum which seemed adequate.

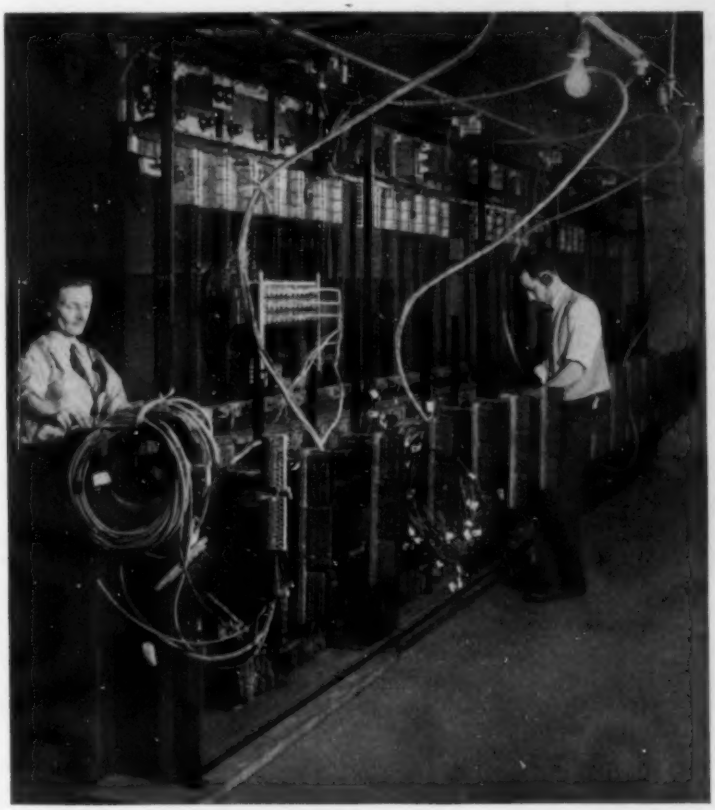
The photograph on page 180 shows some of the reels of cable in storage at one of the several concentration

points. Every reel is in the clear, and in case of emergency can be loaded directly on a truck or cable trailer at a moment's notice and without unnecessary handling. To facilitate locating quickly the particular length, size, and type of cable desired, and to avoid possible error under the stress of emergency, each reel is plainly stenciled with the necessary identifying information, as pictured on page 181. This plain marking of each reel also serves the purpose of identifying each item in connection with periodic inventories.

Central Office Equipment

SPEED CAN BE GAINED in restoring a destroyed central office to service if the equipment to be installed is pre-engineered to workable sizes of units and all of the necessary material for a complete installation is selected, crated, and clearly marked.

Central office war-time emergency stocks were designed to meet these



A SECTION of used No. 1 manual switchboard is here being rewired before being stored away ready for immediate use

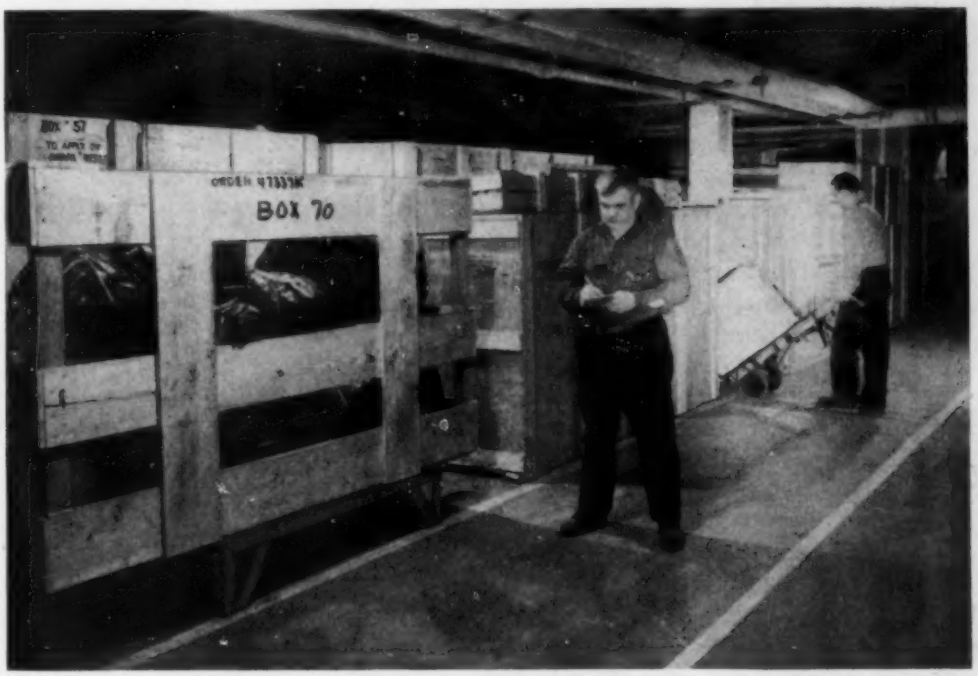
requirements. In preparing the various packaged units of central office equipment, all shop assembling and connecting that is practicable has been done in advance. Cables have been connected and coiled for immediate use. Every step has been taken that could facilitate portability and quick installation of the units. Items of miscellaneous equipment required for quick repairs have been boxed and distinctly marked and numbered, somewhat as is shown for the cable-reel marking shown on page 181.

TELEPHONES USE POWER to operate. In this picture, units of power equipment are being reconditioned: left, a battery charging generator; center, a ringing machine; right, a power distribution panel

When a central office, either manual or dial, is completely destroyed, it can be restored to service most quickly by the use of manual equipment. Less detailed engineering is needed to adapt the equipment to local conditions; and, since it is less complicated technically, the time required for installation is shorter. Manual equipment also lends itself better to the necessity for pre-engineering into packaged units. Plans for restoration of a completely destroyed central office are based, therefore, on the use of manual equipment.

Eight prefabricated and packaged units of the large capacity No. 1 type of local manual central office equipment, each capable of furnishing serv-

ice to 1200 lines in a multi-office metropolitan area, have been provided. The picture on page 183 shows a portion of one of the used switchboards in the process of being assembled, wired, and connected in the shops. On page 184 is shown the



A COMPLETE central office unit, packed for immediate shipment and installation. Comprehensive lists are maintained of the equipment and materials in each of the numbered cases. Box 70, for instance, contains power equipment

ringing machine and a portion of the power equipment for the same unit. Part of a completed packaged unit being placed in storage is pictured on this page.

Additional No. 1 manual equipment has been provided—but not packaged—for enlarging the packaged units where necessary. The amount of this equipment is approximately equal to 15 of the packaged units. For the smaller cities which are served by one central office building, five complete prefabricated and packaged units of the smaller capacity No. 12 type of local manual central office equipment, each unit capable of furnishing service to 1000 lines, are being provided.

As it is considered desirable to provide manual service for any swift restoration of a completely destroyed office, no attempt has been made to stock dial equipment for this purpose. To restore service in partially damaged dial central offices, however, frames, shelves, selectors, banks, and

other miscellaneous material for step-by-step, panel, and crossbar offices have been provided. It is interesting to note that the crossbar stock consists of two complete partial units which were manufactured and shipped to Associated Companies; but government restrictions halted their installation, and they were thus available for the war emergency stock. This material will be retained in its present state and location for the duration, and will be resold to the telephone companies if not required for restoration use.

TOLL SERVICE is of particular importance in war-time, and elaborate precautions must be taken to insure that no important community becomes isolated through damage to its telephone facilities. This problem has been studied city by city, and arrangements have been provided so that emergency calls can go through under the severest conditions of war-time damage. Quick restoration of a substantial toll service beyond these emergency needs presented a difficult problem. It was solved by the design of special switchboard circuit facilities undertaken months before Pearl Harbor.

Four complete units of No. 3 type toll inward and tandem equipment incorporating specially designed circuits, pre-engineered and packaged with all necessary material for installing them, have been provided. Each unit, in association with existing manual or DSA switchboards or any type of emergency central office or PBX position, will handle 500 or more outward calls per hour and a corresponding number of inward calls.

Various miscellaneous equipment required in repairing damage and quickly restoring service has been provided. One example is the subscriber long-line circuits which will permit telephones whose regular central office has been destroyed to be connected to a more distant office. Distributing frames, protectors, cable tips, jumper wire, switchboard cable, power plants, and other such material for repairing or replacing vital parts of central offices which may have suffered war damage are also stocked. In general, this material too is all packaged and the boxes numbered for easy identification and immediate shipment.

Stocks of Open Wire

CLOSELY RELATED to the provision of war emergency stocks on a System-wide basis is the program undertaken by the Associated Companies, as a consequence of the growing scarcity of metals, to establish stocks of used copper wire to be held for storm restoration needs of the System's 2,500,000 miles of toll open wire.

These reserves have been built up chiefly from wire which became available when the circuits on certain open-wire lines were transferred to recently completed paralleling toll cables. This wire was carefully removed, inspected and repaired, reeled into coils, and is held at numerous locations in the territories of the various Bell System companies. A collective total of about 550 tons of wire was made available for this purpose by the several companies before the 1942–43 winter storm season.

Since the amount of this wire held by any one company might prove in-

adequate in the event of a particularly bad storm, arrangements were made whereby one Bell company can quickly draw on the emergency stocks of neighboring companies if its own reserves of wire should prove insufficient to meet its requirements for storm restoration. Fortunately, the storms of the past winter did not result in heavy destruction of toll open wire, and only one inter-company exchange proved to be necessary.

The companies plan to have wire reserves of approximately the same amount—i.e., 550 tons in total—available for the coming winter. All of this will be salvaged wire. Although it will represent less than a quarter of one percent of the toll copper line wire mileage in service, it should, in the light of past experience, prove adequate to meet the immediate requirements of storm restoration.

EXCEPT FOR the copper line wire just discussed, the emergency war stocks here described have been assembled, stored, and set aside wholly and solely for use in restoring telephone service to operation after damage resulting from sabotage, air raids, or similar cause. The materials and equipment represent a substantial sum of money. Obviously, they are unproductive—from the near viewpoint, at any rate, of providing relief to the System's presently overburdened plant. Yet if no reel of cable nor switchboard section nor so much as a bolt or screw were ever to be taken out of storage until the day of peace—as it is devoutly to be hoped they never will—they stand as a wise and necessary investment.

For upon the Bell System rests the responsibility for so much of the country's telephone service, and the continuity of that service is of such incalculable importance to the nation at war, that the System must make adequate provision against every foreseeable contingency. In the creation of war emergency stocks lies one more indication of full recognition of this responsibility.

INVESTING WELL for the future means getting the best personnel, the best materials, the best credit. The best is usually higher priced but less costly than poor credit, poor personnel and poor materials. The theory is to pay fairly for quality and get it, because quality well managed means ultimate economy. That is the long view. A hit-and-run management with a short view can make immediate savings by chiseling on the cost of credit, by chiseling on wages and salaries and chiseling on materials and margins of safety in plant and operation, and cutting down on the staff work and research—the men whose job it is to work for improvement. But such immediate savings will cost heavily in the long run.

From "The Bell Telephone System," by Arthur W. Page, Vice President, A. T. & T. Co. Harper & Brothers, publishers, 1941.

The Re-design of a Screw and the Re-use of Tons of Copper Wire Are But Two Examples of Bell System Conservation of Materials Which Are Vital to the Winning of the War

Getting Along with What We Have

Bayard A. Freed

ONE OF THE very many ways in which the war is affecting the Bell System was stated succinctly by President Walter S. Gifford of the American Telephone and Telegraph Company when he said, on a "Telephone Hour" radio program not long ago: "For the duration of the war, we shall undoubtedly have to get along with substantially the plant and facilities we now have."

Mr. Gifford's reference was, of course, to the now well understood fact that copper, steel, aluminum, tin, rubber, and other materials normally consumed in large quantities in telephone construction, "have gone to war," and that the manufacture and installation of new plant and equipment are strictly limited to uses which either contribute to victory or are essential to public welfare and health.

To get along with substantially the plant and facilities now in use, in the face of the rising flood of demands upon telephone service resulting from the war, calls for ingenuity of a high order—and for plenty of it. It also calls for many departures from the materials and practices which, as both experience and research have demonstrated, provide the best possible service most economically.

A list of the multitude of things that have been done to save materials would fill many pages of this MAGAZINE, and a complete description of them would fill a book. Thousands of pieces and parts of apparatus have been re-designed to substitute the more abundant and less critical materials for the more critical; equipment has been re-designed to use less material; parts are being made to do longer service before being replaced; material which would normally be scrapped for salvage is being repaired and put back in service; and many

new maintenence and engineering practices are being employed.

A few selected examples will serve to illustrate some of the new practices, equipment, and techniques which are making it possible to use so little material as compared with what would normally be required to take care of the great increase in telephones and long distance calls.

THE HOUSING of the outdoor telephone set is now made of wood instead of metal

Telephones

YOUR TELEPHONE SET is a good example with which to start.

In the latter part of 1941, the new "combined" telephone sets were being manufactured at a rate in excess of 2,000,000 a year. That rate rapidly diminished during 1942, and manufacture ceased last Fall. But the number of subscribers has continued to increase at the rate of more than a million a year. How has it been possible to serve them without making as many new telephones as usual? The principal answer is found in the fact that about 750,000 of the earlier types of telephones, including many of the upright desk-stand type, which were displaced by more modern sets, were not thrown out but were set aside so that they would be available for use in an emergency. Thanks to that foresight of some years ago, these earlier sets are now being reconditioned and placed back in service, and stocks of them are being transferred from one Associated

THIS INGENIOUS little contrivance paints drop wires while they are in the air, so that they need not be lowered to the ground

Company to another to equalize the available supply.

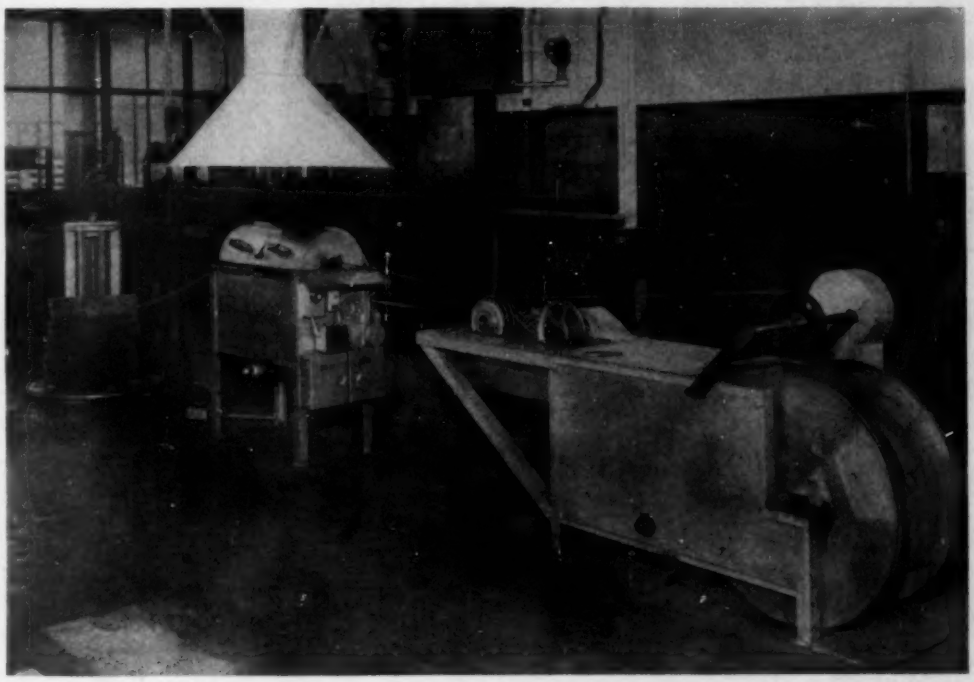
Working stocks of telephone sets have also been reduced in order to place every possible telephone in use. Normally each installer had a few spare sets in his installation truck or in his locker to meet such contingencies as breakage, changes in orders, or special orders. Now he carries only enough sets to meet actual service-order needs. Moreover, the number of sets left in place in vacant premises where there seems to be some likelihood of reconnection before long has been decreased. This sometimes makes it necessary, however, to re-install telephones at locations where left-in equipment would otherwise be available.

Less new material is being used to repair telephones than was formerly the practice. The flexible cords on your telephone once were replaced when they became frayed, but now they are not replaced until they become electrically inoperative; cords which are merely frayed are wrapped with tape. Parts within the set are also being allowed to wear longer before being replaced.

SALVAGED DROP WIRE not in serviceable condition is returned to a Western Electric repair shop, where it is carefully inspected and spliced into convenient lengths

Some customers need telephones in out-door locations, and a special set has been provided for this purpose. The set as manufactured in the past was specially designed to withstand

the weather, and required the use of many special parts. Recently, however, it has been modified so that it may be assembled from parts which are commonly used for other purposes. The housing was originally of aluminum; when that became scarce, cast iron was used instead; and now, because of the scarcity of iron, the housing is made of wood.



SPECIALLY DESIGNED APPARATUS is used to re-impregnate drop wire with weather-proofing compound. Left to right: pay-out reel, compound tank, setting tank, and take-up reel

Drop Wire

WHAT IS BEING DONE in the case of drop wire provides another good example of how the System is continuing to "get along with what we have."

Drop wire, the important last link between the telephone line and the customer's premises, consists of twin copper-clad steel conductors separated by rubber insulation. Over the insulation is a fabric braid impregnated with a weather-resistant compound. Continued exposure to the weather results in the leaching out of this compound, with the result that sunlight penetrates the braid and causes deterioration of the rubber insulation. In normal times, a drop wire which is deteriorated and worn is replaced by a new one, because it is cheaper to use the small amount of new wire that is required than to spend time making repairs. In these

times, however, worn sections are cut out and new sections are spliced in, if the drop as a whole is not too badly deteriorated.

The life of drop wires which are not so badly worn as to require replacement is being prolonged by painting them with a compound. Two new tools have been developed for this purpose. One is intended for use on drops which must be lowered to the ground for inspection or repair. The other permits painting drop wires while they are in the air.

Normally, recovered drop wire showing signs of deterioration or wear is scrapped for salvage. But now, all wire removed from service is carefully picked over, to salvage all sections which might possibly be re-used. These good sections are spliced together and the braided covering is reimpregnated with a compound by means of recently designed machines located at strategic points throughout the country. Last year some 35,000,000 feet of worn recovered drop wire were reconditioned and re-used. Its re-use saved 80,000 pounds of copper, 150,000 pounds of rubber, 220,000 pounds of steel and large quantities of less critical materials.

Reforming Small Springs

IN PANEL TYPE dial central office equipment are small, paper-thin, finger-like bronze springs about two inches in length, commonly known as commutator brush springs. When you twirl the dial on your telephone, you cause these springs to move up along a bar somewhat like a yardstick; when they cease their travel and you begin your conversation, they form a part of the electrical path over which you talk. When you hang up, these little fingers slide back down the bar to their original position. In the course of time, the 1/32-inch crooks on the ends of these finger-like springs wear off from repeatedly sliding up and down on the bar on which they press, and when this occurs noise and other troubles may develop.

It was formerly the practice, when these little springs were worn down to the point where they were likely to cause trouble, to take them out and install new springs—this being more economical than repairing the old ones. To conserve copper and tin required to make replacing springs, worn springs are now taken out and, after being reformed and recentered, are placed back in service instead of being scrapped. Because the springs are so small, and because of the accuracy with which the work must be done, the job of reforming them borders on watch-making technique. The amount of metal saved by avoiding replacement of a single spring is, of course, small. But the annual savings assume real significance when it is realized that of the 1,500,000 of these springs in service, about 50,000 must be repaired each year.

The commutator brush spring is just one of many similar springs and contacts that are being reformed or repaired, and methods for repairing still others are in process of development. Another instance of a seemingly small saving is the case of a little screw used for fastening one end of the cord on your telephone. This screw was originally made of brass, an alloy of copper and zinc, but is now made of zinc-coated steel. This change saves more than 8,000 pounds

of copper yearly, although the amount of copper in each individual screw weighs no more than a common pin.

Supplementary Cabinet for Handling Long Distance Calls

WAR INCREASED phenomenally the number of long distance conversations in 1942. To handle this great increase in calls, much larger quantities of critical materials would have been required for additional switching equipment, wires, and cables than were actually used, had not various expedients been adopted. Among these expedients are changes in the methods of handling long distance calls in order to avoid using additional materials. Generally, these changes increase somewhat the time required to complete calls and add to the number of operators that must be used for this work.

A good illustration is the small table-mounted cabinet used to augment switchboards handling outgoing long distance calls, the use of which avoids installation of additional switchboard positions. Each cabinet serves two operators, and these operators, with limited assistance from operators working at the regular switchboard positions, can generally do all work connected with handling outgoing long distance calls.

THESE SUPPLEMENTARY CABINETS used for handling long distance calls contain less than one-sixth of the metal in regular switchboard positions—although requiring twice as many operators to handle the same volume of traffic

Because of certain limitations, the operation of the cabinets requires double the number of operators that would be required to handle the same number of toll calls on regular switchboard positions. In these times, the disadvantage of using twice as many operators is outweighed by the fact

that each cabinet contains only 60 pounds of critical metals, whereas there are about 400 pounds in a switchboard position.

Re-using Copper Line Wire

LARGE QUANTITIES of copper line wire are removed from service by the Bell System each year as open wire lines are replaced by cable, because of shifts in locations of the lines due to road changes, and for other reasons. Normally, recovered copper line wire is scrapped, because its salvage value is high as compared with its cost new and because the cost of removal is greatly increased when it is necessary to avoid the nicks, breaks, and snarls which may occur and which make the wire unfit for further use as line wire.

Early in 1941, when the shortage of copper began to develop, the System was using copper line wire at the rate of about 25,000,000 pounds a year. In order to reduce the requirements for new copper wire, steps were taken at that time to develop methods and equipment which would permit taking the wire down in such condition that it could be re-used. This resulted in the re-use of about 9,000,000 pounds of copper line wire in 1942 for making essential additions to long distance circuits. Currently the System's entire needs for copper line wire are being met from wire thus recovered.

The new methods for getting the wires off the pole lines differ materially from those used ordinarily, and many of them were worked out by linemen and foremen on the job. Pages from their notebooks of experience were consolidated in a single set of instructions by the staff engineers of the A. T. & T. Company, and were in turn disseminated to line crews throughout the System. One bothersome problem encountered in developing the new methods was that of preventing the wire breaks which occurred when wire ends projecting from the old type (twisted sleeve) joints caught on the crossarms. This was solved by one experienced foreman who said, "When we used to put up wire with twisted sleeve joints, we sometimes used marline to cover up the sharp ends of the joints. We can do the same thing to get it down." This illustrates well how practical ideas contributed by craftsmen are helping to conserve materials.

The "Victory" Joint

FOR YEARS—since long before the first telephone cable was made—it has been the practice to join lead pipes together by means of solder. This technique, borrowed from the plumbers, has also been used for years in making joints in lead covered cables. Sufficient solder was invariably used on each joint so that, when finished, it had a rounded, ball-like shape.

When it became apparent that there was likely to be a shortage of tin, a new type of joint which has become known as the "Victory" joint was introduced. In this joint there is only a small fillet of solder at the junction between the sleeve and the cable sheath, instead of the former ball-like section of solder. The amount of solder in a "Victory" joint is less than 40 percent as much as in the older joint; and inasmuch as the solder used for wiping joints consists of about one-third tin (nearly all of the rest is lead), the "Victory"

joint has been an especially effective measure in conserving the use of tin —of which there is such a scarcity. This new technique saves about 110,000 pounds yearly in the amount of tin that is used for maintaining and repairing existing cables. There is also, of course, the additional saving made in splicing new cables—but there is comparatively little of this being done at present.

THE SPECIALLY designed take-up reel avoids damage to copper wire during removal. Wires are wound into individual coils

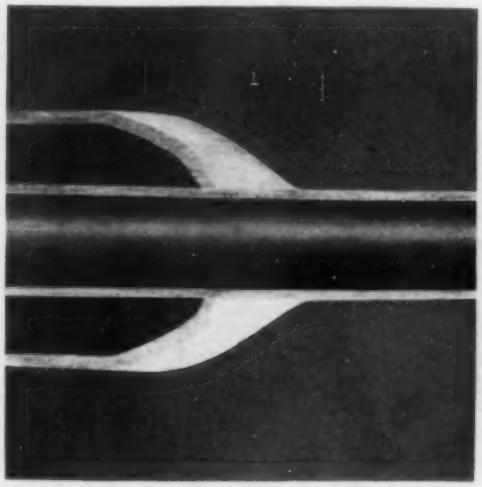
In order to expedite the introduction of this new technique, demonstrations were given at a number of places throughout the country to representatives of all the Associated Companies, skilled in splicing work, so that they could introduce it in their respective companies. These instructors, having learned how to make the new joint, returned to their companies and proceeded at once to teach the technique to the splicers. Within a brief six to eight weeks after the new technique had been introduced, it was in daily use by more than 5,000 splicers throughout the Bell System, most of whom were

highly skilled through years of experience in making the rounded joint.

The "Victory" joint will doubtless be continued in use after the emergency has passed.

MANY MORE EXAMPLES could, of course, be cited, but these illustrate the great variety of things that are being done to save materials, and demonstrate that attention is being given to small savings as well as to large.

All engineering and operating practices have been closely scrutinized, and every individual item of equipment down to the smallest screw has been carefully examined. Modernization programs, such as conversion of central offices from manual to dial operation, have been discontinued. Plant additions since March, 1942, have, in general, been restricted by order of the War Production Board to those essential to the war effort. In combination these conservation measures have reduced the rate of use of copper from more than 90,000 tons per year (the peak rate obtaining in 1941) to the present rate of about 6,000 tons. Use of aluminum has been correspondingly reduced from 1,200 tons to 25 tons, and of rubber from 2,100 tons to 130 tons.



THE OLD SHEATH JOINT had a large cross-section of solder

SOLDER MUST be of exactly the right composition and temperature

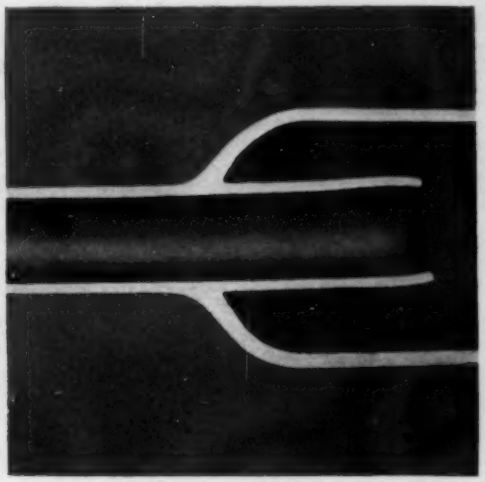
The situation surrounding the supply of raw materials is shifting rapidly. Substitutions are now being made for materials which themselves had previously been used as substitutes, as is illustrated by the housing of the outdoor telephone set. Likewise, other conservation measures are having to be modified to meet changing conditions. So the general staff organization of the A. T. & T. Company, through its close association with engineering and operating per-

sonnel, is constantly seeking new ideas on ways to save materials. All ideas which appear to have possibility of general application are studied carefully and, if needs and possibilities warrant, are developed further. Information on new practices which are found to be of general value is quickly disseminated to all of the Associated Companies.

Development and application of conservation measures have been greatly simplified by the fact that standardization is one of the cornerstones on which the Bell System has been built. Because of the high degree of standardization that pervades the System, ideas and experiences originating in one Associated Company can generally be applied directly by all other companies; a worth-while idea for saving material originating with an installer in Sequim, Washington, may be applied directly by an installer in Miami, Florida, since both men work with the same materials and tools and do their work in the same way.

The development of ways of saving materials has not been confined to any one branch or department of the System. All branches have made important contributions, and there is scarcely a phase of the telephone business that has escaped scrutiny. The Bell Telephone Laboratories, from the fund of information accumulated in years of systematic research, have found substitutes for the scarce materials. The Western Electric Company, through its knowledge of materials and manufacturing operations, has greatly expedited introduction of these substitutions and has developed other changes in manufacture which have resulted in large savings in material. The Associated Companies, with the coöperation and

IT TAKES a skilled craftsman to wipe a joint in a cable



THE NEW "Victory" cable joint has only a thin fillet of solder

assistance of the general advisory staff of the A. T. & T. Company, have devised and put into effect many material-saving modifications of their engineering and operating practices.

All of the ingenuity, all of the strategems and expedients being employed to save materials have been developed with the double purpose of aiding the war effort in the greatest possible degree and, at the same time, continuing to give as good service as possible to as many customers as supplies and limitations will permit. The Bell System, rendering an indespensable communication service to the nation at war, will continue to stretch what it has to encompass what it must do. The materials it uses and those it saves are both contributing to victory.

HERE'S A STORY that has come to light about war communications and a small body of commandos on the island of Timor, north of Australia.

The Japs came suddenly and the party of commandos was cut off—stranded. They had precious little equipment, and no communications whatever to the Australian mainland.

One day scouts came in with a couple of battered old radio sets they'd hauled through 40 miles of enemy territory. "This stuff do us any good?" they asked.

Well, there were five radio men in the squadron. They looked at the tangled mess, scratched their heads, then started to work. Before long, out of scraps of wire, solder, and tin, plus some parts of their old transmitter, they had rigged up something. They got electric power from an old automobile generator. They swiped a battery charger from the Japs. Then, with their hearts skipping a beat, they sent out a signal. It got through. Communications with Australia were reopened after two months' silence.

Fighting men of the United Nations usually have the best communications equipment in the world. But they also have the ingenuity to get along even when they have only odds and ends to work with. In jungles, deserts, and icy wastes our own Signal Corps men are performing miracles every day. We like to keep track of these men and their accomplishments—for of the 50,000 Bell System men and women now in the armed forces, thousands are in the Signal Corps, working on vital communications jobs. And backing them up here at home are 415,000 other workers in the Bell System alone. They are in the war—keeping up the nationwide network of telephone lines that helps tie together all parts of the biggest job this country has ever undertaken.

From a "Telephone Hour" radio program.

Science Is International

Karl K. Darrow

This text of one of a series of radio broadcasts under the auspices of the American Philosophical Society, delivered by Dr. Darrow on June 24, is given here as illustrating another side of the story which was told in "American Science Mobilizes for Victory" in the preceding issue of this MAGAZINE.

I HAVE BEEN ASKED to speak on internationalism in science, or rather in the particular field of science which happens to be mine, the field of physics. The quickest way to handle this subject would be to reverse it, and speak of *nationalism* in science. This would be a conveniently narrow subject, for in science there is hardly any nationalism. The laws of Nature are everywhere the same, and the ways of describing them do not differ from land to land. You may indeed remark that in different lands they are described in different languages. Insofar as this is true it is not important, except as an inconvenience; and it is not even entirely true. The laws of Nature are described by mathematics, and mathematics is a universal language. You can look at a book of physics in some language of which the very letters may be unfamiliar, and still you can tell what the author is treating by following the train of his equations. If you can read his words or get someone to translate them, you find that there is no imprint of nationality on his ideas, any more than on the laws which he happens to be describing.

So, the journals and the books of science are a cosmopolitan literature, and indeed the most cosmopolitan thing which now remains to us. In the happy days before the other war, there were other cosmopolitan things: the gold standard, and the free circulation of art and of artists from country to country, and the worldwide diffusion of travel and trade with limitations so light that they now seem like freedom. These did not survive the other war, or survived it only in a crippled fashion; but the literature of science continued still to pass all boundaries even when its creators could not, a sort of intellectual gold standard by which the worth of every contribution and the standing of every contributor were appraised. Englishmen were not judged by Englishmen exclusively, nor Germans by Germans nor Americans by Americans; the common opinion of the scientific world was the court of first and last resort.

No experiment was disregarded, no idea neglected because it came from the opposite side of a frontier. Few if any scientists strove to keep their ideas confined within their own countries. The notion of keeping a

discovery undisclosed is repugnant, I can without exaggeration say it is revolting, to nearly every man of science. So few are the exceptions to this rule that we still look with wonder on Newton and on Cavendish, who were exceptions to it, and try to divine what peculiar quirk of personality made them such deviations from the norm. Nearly every one in science spoke to all who would listen, and nearly everyone in the entire world of science was ready to listen to a new experiment or a new idea, from whatever part it came.

BUT EVEN SO, were there not some nations which were always the discoverers and the teachers, and others which were always the copyists and the learners? Nothing would seem more natural, and nothing could be further from the truth.

Take the four men whose consecutive labors enabled us to understand the motions of the heavenly bodies: Copernicus the Pole, Galileo the Italian, Kepler the German, and Newton the Englishman. They were astronomers but they were physicists also, for the laws of motion of the heavenly bodies are those of earthly bodies also, exemplified on a grander scale.

Take the story of radioactivity. Radioactivity was discovered because X-rays had been discovered. The discoverer of X-rays was a German, but the man whom his work inspired was a Frenchman. Another Frenchman and his Polish wife carried on the study, and for a time it might have been thought that Paris was destined to be the centre of all wisdom about radioactivity for ages to come. Not for a very long time, however! Not a decade had elapsed before everyone who cared at all about this field was looking eagerly to England, and not because of an Englishman either, but because of a New Zealander whom a fellowship endowed in Britain had brought to Cambridge. The focal point of research in radioactivity traveled with this man to Montreal and then back again to England.

It is Rutherford of whom I speak, the very man who later became the first of all men to achieve the transmutation of the elements. So long as he lived, the great Cavendish laboratory at Cambridge was the greatest scene of transmutation in the world. Now the art and science of transmutation are dispersed throughout all countries; they are cultivated in America most of all, largely because Americans invented the two very ingenious devices which are used to produce the very high voltages demanded for transmutation. It was, however, an Italian who first taught the world to use the most variously efficient of all of the agents of transmutation, the agent which we call "the slow neutron."

I could tell the same sort of story for almost every achievement in physics, and the lesson would always be the same. Progress in science depends on the spirit of the brilliant man; and in this case above all, the spirit bloweth where it listeth, heedless of national boundaries and heedless of racial groups. There has never been a city which was the capital of physics as Vienna for a century was the capital of music. There has never been a nation which was preeminent in physics as France for so many years was preëminent in paint-

ing. Metaphorically speaking, if you walk through the galleries of physics you do not find the masterpieces labelled "French School" or "Dutch School" or "Italian School." There is just one school of physics, and from its inception it has been the school of all civilized nations.

THOSE OF MY LISTENERS who heard the prior programs of this series are probably expecting something more. You may be waiting now to hear me tell of some great scheme or schemes of formal international cooperation, set up and going on for the benefit of physics. But those who speak for other sciences, astronomy for instance, can give you more striking examples than I can. I might indeed mention the laboratories built and the equipment given by the Rockefeller Foundation for physicists in certain European lands—laboratories now, by tragic irony of fate, ruined by civil war or taken over by the Nazis. It is allowable to hope that soon they may again be serving their intended purpose, and that the example of great donations by private wealth across frontiers may survive to be followed by future generations.

More significant as yet has been the living aid interchanged by the nations. I mean the students who have gone from their homelands to some other country, not to sit at the feet of a famous master (as the saying used to be) but to stand beside him and work with him upon some problem of his own selection. Few of the leaders of physics have worked entirely by themselves. Normally, the brilliant physicist requires aid, and the skilled, intelligent aid of men who are almost his peers, to follow out the ramifications of his thought and to perform the experiments suggested by his ideas.

Mostly his fellow-countrymen supply the aid, but not by any means always. Many a Canadian and many an Australian has brought his stone or stones to the edifice reared by a British physicist; many an American has done the like for a German in the days before the other war and in the days of the Weimar republic; many a Chinese and many a Japanese has done it for an American.

The graduate schools of many a university were microcosms of a nonembattled world, little groups composed of many strangers working together in a comity and with a mutual understanding such as we all should like to see realized in the world at large. We ought to try to increase their number after this war, and do away with certain formal restrictions which impeded them from arising in certain parts of the world. Yet if there had never been any such group, or if there were never to be any such group again—even in that deplorable and highly unlikely case, science would still be international. It would be inevitably international, so long as the books and the journals were allowed to cross the frontiers. Every physicist sooner or later, and glad or sorry as he may be, finds collaborators springing up all over the world. They are taught by his experiments and by his calculations, and he is taught by theirs.

It could not be otherwise. Ideas flow about the world like the lifeblood in an organism. If from any part of an organism the flow of blood is withheld, that part decays. The

same is true of the organism of science and of thought. If anyone doubts this, let him look upon the demonstration which for the past ten years has been presented by the enemy.

From Malang to Omaha

WHAT PRICE an overseas telephone call? Here is one answer, quoted from "Queens Die Proudly," the saga of the Flying Fortresses of the 19th Bombardment Group of the U. S. Army Air Force, which was stationed in the Philippines in 1941. Most of the squadron's planes were destroyed and many of the personnel were killed when the Japanese attacked Clark Field on December 8, 1941—which was, of course, December 7 on the other side of the international date line. Later that month the remnants of the squadron were ordered to Australia, and then, on December 31, to Java. There they set their planes down on an airfield near Malang and went to a hotel in that city for dinner. The narrative is in the words of Lieut. Col. Frank Kurtz, holder of the Distinguished Flying Cross and the Silver Star, who was pilot of one of those queens of the sky which fought to the death above the Philippines, Australia, and Java; and of his wife, Margo:—

"AS SOON as we'd ordered," said Kurtz, "I asked the manager what was the best way to get in touch with America (I didn't know what the war might have done to the cables) and was completely floored when he asked me why didn't I telephone? Seems he'd talked to New York just two days before. So I rushed to the telephone, and there in the center of Java I gave the operator Margo's phone number in Omaha. It seemed crazy. Halfway around the world. Here in Java it was the evening of one day, and if the call went through Margo would be talking in the morning of the day before. God knows the old Fortress gobbles up time and space, flicking off the meridians like a boy rattling a stick along a picket fence, but the radio telephone could turn night into day with the click of a receiver. I just couldn't believe the call would come through, but meanwhile I didn't have the $27 for three minutes, and went back to the table, where we pooled our money."

"I was doing volunteer work at air corps headquarters in Omaha," said Margo, "when they told me the overseas operator was trying to reach me out at the house. I knew it could only be from Frank. Or about Frank. I ran out of the building. It was five blocks to the parking lot

where I kept my car. I remember I decided I'd better stop running because if I was out of breath I couldn't talk.

"I remember the man in charge of the parking lot looking at me curiously and asking if something was the matter and didn't I want him to drive me home. I guess I must have been crying. I said no but please hurry and get the car out.

"When I got home the overseas operator in San Francisco said a tropical storm was delaying the call, and it might be an hour. It was three. Then I could hear them working, telephone girls talking all around the world, trying to help us, trying to set up a line. You get to love those operators—they're like nurses at the sickbed of someone you love—doing everything they can. Finally it's the girl in Batavia, Java, and then some town I'd never heard of—girls with queer accents—all helping you, and then a hotel switchboard and at last Frank's voice. I couldn't understand the words but that didn't matter at all—that was the least I cared for. Because you can get a cable and by the time you slit the envelope the boy who sent it may be dead in a trench or on a pine-clad mountainside, but when you hear the voice you know he's alive.

"But the words were all chewed up by the crackling of that tropical storm—or it may have been a storm over Finland—and I could hear the censor clicking in and out. And then somewhere a layer of electrons would bulge upward and Frank's voice would fade out entirely for a few seconds and then come back in. At last I understood he was trying to tell me where he was, and for me to call him back because he didn't have any money left.

"Now he was trying to spell out the name of the town! 'M— A—' I would get that much and then it would fade out and I would get a terrible feeling of panic—that the little thread would snap, and I'd never know how to get in touch with him. But just then that sweet censor broke in and relayed the name to me —Malang, Java.

"Then Frank was trying to tell me the name of the hotel. And I was shouting, 'Frank, are you saying the Alice?'

" 'Like in San Francisco,' he was telling me.

" 'The Palace?'

" 'Yes.'

"Then I could hear a girl's voice with a Dutch accent telling him his time was up.

"And now it seemed I was floating on air and I wanted to run out and tell everyone I had a live husband who was in the Palace Hotel in Malang, and I knew he was alive because I'd heard his own voice two minutes ago. That nice feeling stayed with me for days, and made everything all right for a long time."

From "Queens Die Proudly," copyright, 1943, by W. L. White. Reprinted by permission of Harcourt, Brace & Co., Inc., publishers.

Who's Who & What's What

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system development for five years, and returned to the parent company in 1939. In 1941 he was appointed to his present position of Equipment and Building Engineer of the O. & E. Department.

HOW CAN THE COAT of increasing service demands be cut to fit the cloth of drastically curtailed stocks of materials? Some part of the answer to that poser is found in the examples which BAYARD A. FREED cites of how the Bell System is stretching the cloth to fit the pattern of its needs. Mr. Freed was with the Pacific Telephone and Telegraph Company in outside plant work from 1921 to 1929. With the A. T. & T. Company since then, in the O. & E. Department, he has been engaged in both outside plant and sales activities, and since 1942 in plant extension work.

THE BROAD OBJECTIVES of science—and scientists—may be temporarily diverted by war to nationalistic ends; but, as KARL K. DARROW makes clear, in true perspective science knows no boundaries of country nor of race. With B.S. and Ph.D. degrees from the University of Chicago and with two years of study abroad, having specialized in physics and mathematics, Dr. Darrow in 1917 entered the Engineering Department of the Western Electric Company, which in 1925 became the Bell Telephone Laboratories. There his work has included the study, correlation, and representation of scientific information for his colleagues to keep them informed of current advances made by workers in fields related to their own activities. As a corollary to this work, Dr. Darrow appears from time to time before scientific or general audiences to lecture on current topics in physics and the related sciences. He is the author of "Introduction to Contemporary Physics" and "The Renaissance of Physics."

THE HOTEL had no elevator. Guests had to climb the stairs to their rooms, and the staff was always happy to see an inebriated stranger arrive. When he asked where the elevator was, we gravely directed him to the telephone booth. This was a huge contraption at the end of the office that might be mistaken for an elevator car if you didn't look too closely. I have seen a man sit in the telephone booth for twenty minutes, sticking his head out of the booth to holler frantically, "Where's the elevator boy?" We always replied, in modulated tones, "He'll be there directly, sir."

From "Tales of a Wayward Inn," by Frank Case. Reprinted by permission of the author and Frederick A. Stokes Company, publisher.